Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

ECHNOLOGY DEPT.
10 O EMPIRE BUILDING

November, 1944 PITTSBURGH, PA.

TIMKEN Bearing Equipped Slabbing Mill

The application of roller bearings to slabbing mill roll necks is one of the greatest advancements to be made in this type of equipment in many years; perhaps the most important advancement ever made in slabbing mills.

There is only one slabbing mill in the country at the present time equipped with anti-friction bearings on the roll necks — and that one is equipped with Timken Tapered Roller Bearings. It is operating in the Pittsburgh district. The Timken Bearings applied on the roll necks have a separating force capacity of 5,000,000 lbs. at mill speed.

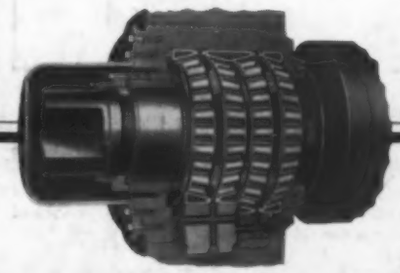
What Timken Roll Neck Bearings have done for strip mills, plate mills, piercing mills and slabbing mills they can do for blooming mills. It will pay you to give this careful consideration, whether you are thinking of buying a new blooming mill or modernizing an existing one. The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

ADVANTAGES OF TIMKEN BEARING EQUIPPED SLABBING MILL

DEC 8. 1
DETROIT

- Greater Tonnage
- Maintenance of Slab Size
- Less Scrap
- Power Saving
- Lubrication Economy
- Reduced Maintenance



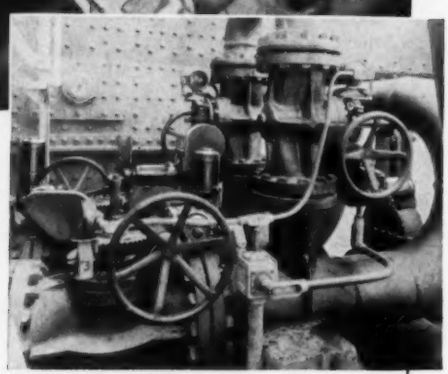
CUTLER-HAMMER

MOTORIZED VALVE OPERATORS

for better process control and plant operation . . .

Do you have valves too large, too hot, too "sticky," too hard to reach for efficient operation by hand? Do you need a simple, better or entirely automatic means of controlling valves in complex refining or chemical processes? Do you want instant operation of valves that are yards—or miles—apart? Do you want to conserve time and manpower in your plant? Or are you looking for valve control that not only *starts* any valve but will seat it safely with *positive protection to seat, gate, stem and mechanism?*

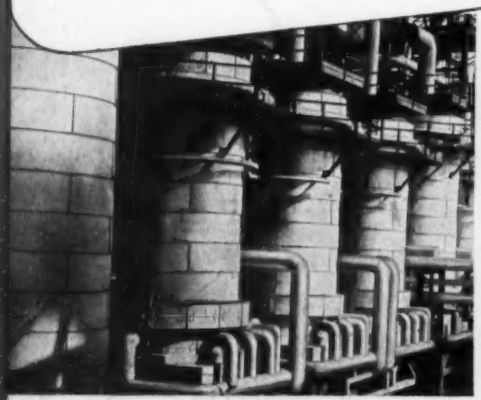
You will find what you want in the Cutler-Hammer Line of Motorized Valve Operators. You will find further, that in choosing Cutler-Hammer Valve Operators for the vast majority of installations, their purchasers are simply recognizing the overwhelming importance of dependability and superior engineering . . . the qualities that have always distinguished Cutler-Hammer design. CUTLER-HAMMER, Inc., 1257 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.



TO CUT BATCHES SHARPLY AND REDUCE CONTAMINATION IN PIPELINE OPERATION

212 Cutler-Hammer Valve Operators on the "Little Inch" pipeline from Texas to New Jersey, uncounted hundreds on other lines, indicate the importance of rapid, fully automatic and centralized control of valves in modern pipeline practice. It gives protection to product quality obtainable by no other means.

CUTLER-HAMMER
VALVE CONTROL
C-H

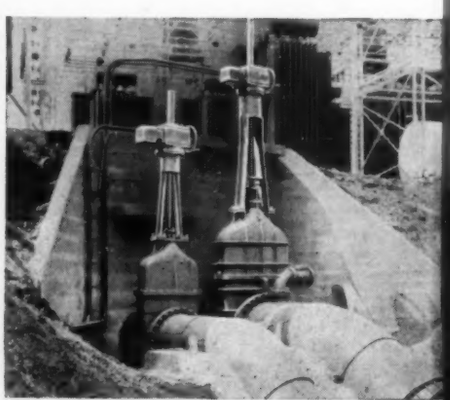


FOR SIMPLE, PRECISE CONTROL IN COMPLEX PROCESS INDUSTRIES

The widespread use of Cutler-Hammer Valve Control in high octane refining processes and other chemical process industries demonstrates the gains that result from fully automatic, often inter-locked sequence control of valves.

WHERE MEN CAN'T GO WHAT MEN CAN'T DO

High pressure, high temperature steam lines and valves often glow red . . . too hot to handle . . . too hard to turn. C-H controlled-thrust-seating operators operate these valves at the touch of a conveniently located push button . . . without danger of jamming.



TO OPERATE A VALVE IN THE NEXT COUNTY *NOW*

Distance means nothing to Cutler-Hammer Valve Control. The operation of any valve or any number of valves in the next room, on the next floor, or miles away is immediate, certain, easy . . . a matter of pushing a button located wherever convenience dictates.

two methods of buying a

Continuous Buttweld Pipe Mill

1

Place orders with several different firms for the component parts, furnace, coiler, descaler, welder, and then engineer and install the mill yourself or . . . . . .

2

Place the order and responsibility for the entire mill with Aetna-Standard. We will design, engineer, and install the mill *complete* from hot mill to finishing floor under one contract. In fact, Aetna-Standard engineers will supply general plans and do the foundation drawings if you wish.

Aetna-Standard Has Built 8 Continuous Buttweld Pipe Mills

Aetna-Standard has had more experience in designing, engineering, and building pipe and tube mills than any other company. In addition to all types of mill machinery, we have been constructing seamless and buttweld mills since 1904. Aetna-Standard, and only Aetna-Standard, has the equipment and experience to engineer and build a continuous buttweld pipe mill *complete.*

DESIGNERS AND BUILDERS to the Steel, Non-Ferrous and Chemical Industries

THE AETNA-STANDARD ENGINEERING CO.

YOUNGSTOWN, OHIO

ASSOCIATED COMPANIES:

HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND

JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA

WEAN EQUIPMENT FOR THE CONTINUOUS COATING OF STRIP STEEL

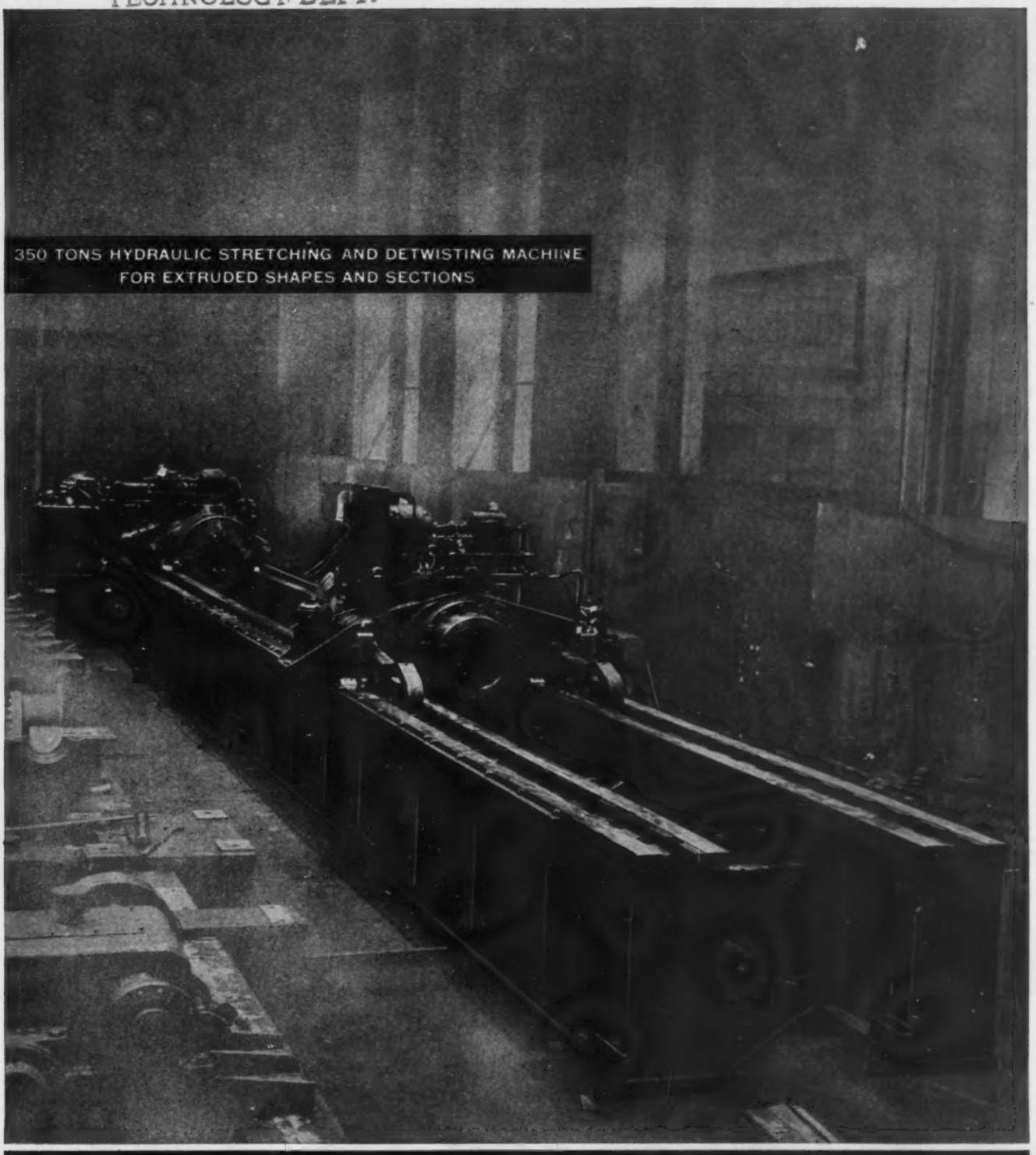
THE Wean Engineering Company is meeting today's demand for equipment to produce tin plate and zinc coated strip steel with light coatings by the electrolytic method; also equipment to produce chemically treated black plate and strip steel. Equipment for coating strip steel with zinc and other materials by the hot dip method is also available.

The WEAN ENGINEERING COMPANY, Inc.
Warren, Ohio

Subsidiary Company
THE BRODEN CONSTRUCTION CO.
CLEVELAND, OHIO

SPECIALISTS IN SHEET, TIN AND STRIP MILL EQUIPMENT

TECHNOLOGY DEPT.



350 TONS HYDRAULIC STRETCHING AND DETWISTING MACHINE
FOR EXTRUDED SHAPES AND SECTIONS

HYDROPRESS · INC.

ENGINEERS *CONTRACTORS*

HYDRAULIC PRESSES · ROLLING MILLS
STRETCHERS · PUMPS · ACCUMULATORS

570 LEXINGTON AVENUE · NEW YORK · N. Y.

Announcing the

HIGH PRESSURE
UP TO 5000 P.S.I.

HIGH TEMPERATURES
UP TO 1500°F.

LOWER MAINTENANCE COST
EASIER TO MAINTAIN
AT HIGH EFFICIENCY

FinFan *Heat Exchanger*

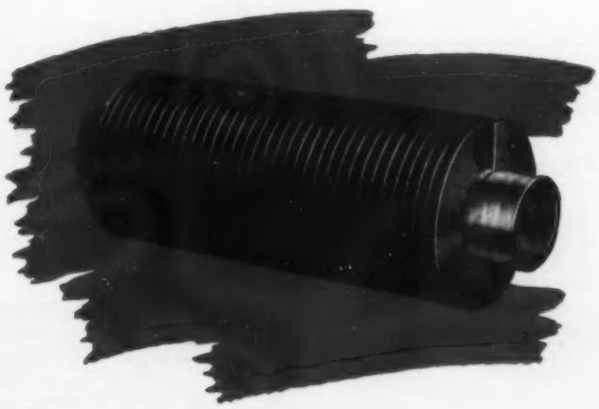
COOLED BY AIR
—FINNED TUBES

The experience and engineering skill of two well-known names in the field of heat transfer—Fluor and Griscom-Russell—have been combined to produce the FinFan Heat Exchanger. This new unit is designed specifically for applications where water is scarce or expensive—or where cooling water at lower than dry bulb temperature is not required . . .. where liquids, gases or vapors under high pressure and high temperature must be condensed and cooled.

The many exclusive features of the FinFan Heat Exchanger make it ideal as a steam condenser, jacket-water cooler or hot oil cooler for all services requiring cooling at temperatures to 1500° F and under pressures to 5000 P.S.I.

The FinFan Heat Exchanger consists of finned tubes, cooled by air circulated through the unit by fans. Maximum flexibility is provided by using two fans to each cell, assuring uninterrupted service even while servicing fans. Vertical air flow prevents recycling of hot air by prevailing winds. Maintenance cost is negligible. Expense of cleaning, descaling and replacement of parts corroded by use of water is eliminated.

The FinFan Heat Exchanger is fully protected by U. S. Patents and Patents Pending.



SINCE 1890

FLUOR

ENGINEERS • MANUFACTURERS
CONSTRUCTORS

Process Plants & Equipment for Oil, Gas & Allied Industries

THE FLUOR CORPORATION, LTD.
2500 SOUTH ATLANTIC BOULEVARD, LOS ANGELES 22
NEW YORK • PITTSBURGH • KANSAS CITY • HOUSTON • TULSA

Having trouble rolling SPECIAL Steels?

. . . Try the NEW ROLL

Birdsboro's new patented Birdsboro Metal Roll was specially designed to make your job of rolling special steels easier. Put these rolls to work in your mill and get higher tonnages, finer finishes, with minimum "down time" and less reduction per dressing.

We'd like to tell you more about the production possibilities in applying Birdsboro Metal Rolls to your mill equipment. If yours is a roll problem, it pays to consult Birdsboro.

BUY WAR BONDS

BIRDSBORO METAL ROLLS
Are used for rolling:

Aircraft quality steel

Alloy steel bars

Non-corrosive steels

Non-ferrous metals

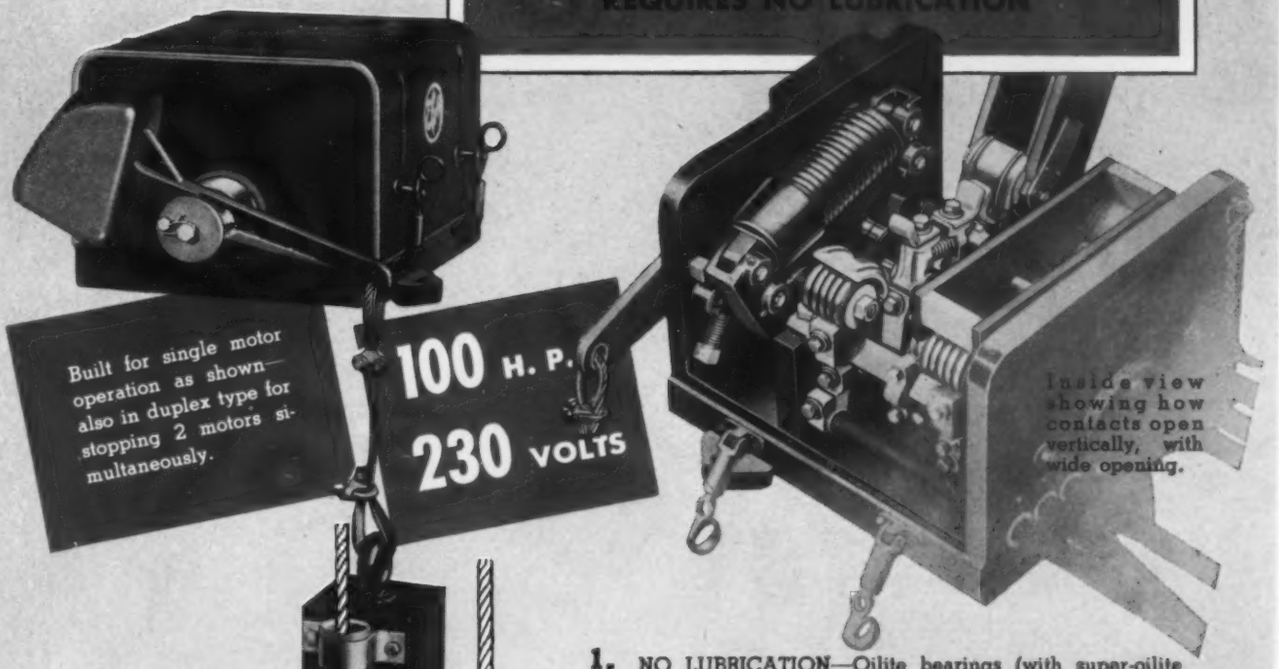
Birdsboro Steel Foundry & Machine Company, Birdsboro, Pa.

BIRDSBORO
ROLLS

NEW NO. 20

YOUNGSTOWN SAFETY LIMIT STOP for CRANES

REQUIRES NO LUBRICATION



Built for single motor operation as shown—also in duplex type for stopping 2 motors simultaneously.

100 H. P. 230 VOLTS

Inside view showing how contacts open vertically, with wide opening.

HAS 9 OTHER Important Features

1. NO LUBRICATION—Oilite bearings (with super-oilite on main bearings) are self-lubricating and of the type noted for their long life.

2. MADE OF WELDED STEEL PLATE—Steel cover and suspended weight from billet stock.

3. HIGH INTERRUPTING CAPACITY—Two normally open and two normally closed contacts, mechanically interlocked and with wide, vertical opening, always assure safe interruption of the hoist motor current.

4. NO DEAD-CENTER CONDITION—Positive roller-type locking device on each side—contacts can not separate in any intermediate position of operating lever.

5. FLEXIBLE POWER LEADS—Equipped with lugs on external ends—may be easily removed when desired—plainly marked.

6. SYNTHETIC RUBBER BUSHINGS—Fit the power leads snugly, exclude dust and provide flexible, nonchafing protection—water and oil resistant.

7. MICA INSULATION—Contacts liberally spaced on mica-insulated shafts to give wide separation between opposite polarities.

8. INDOOR OR OUTDOOR SERVICE—Designed so that snow or ice will not impair operation. Suitable for outside or inside cranes.

9. SMALL RESET TRAVEL—High crane lifts, because the amount of travel between "run" and "tripped" positions, has been kept at a minimum. Split-type, bakelite guide for hoist cable on standard cranes. For multiple-reeved crane blocks, special guides may be bolted or welded to the steel weight.

10. LONG LIFE—Dependable and fool-proof. A test of over ½ million operations has shown the No. 20 is thoroughly sound, mechanically and electrically.

SEND FOR FOLDER 1035

E&M

THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79th STREET CLEVELAND 4, OHIO

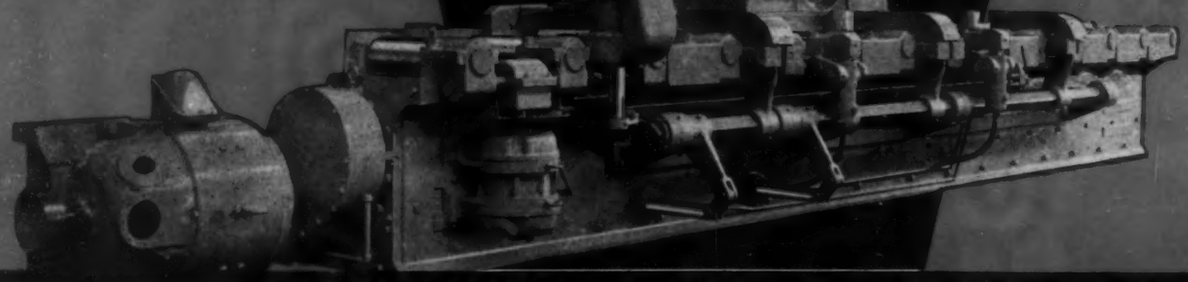
A Crane Without A Youngstown Is As RISKY As A Boiler Without A Safety Valve

This Cutting Head Makes Short Work of Billet Cleaning

MECHANIZE YOUR BILLET CLEANING JOB NOW FOR INCREASED TONNAGE

WITH FINGERTIP CONTROL this Nine Tool Head delivers about 100 cuts per minute for spotting or complete surfacing.

INVESTIGATE THE SPEED & ECONOMY OF BILLETEERS and you will see why they are favored by the majority of mills.



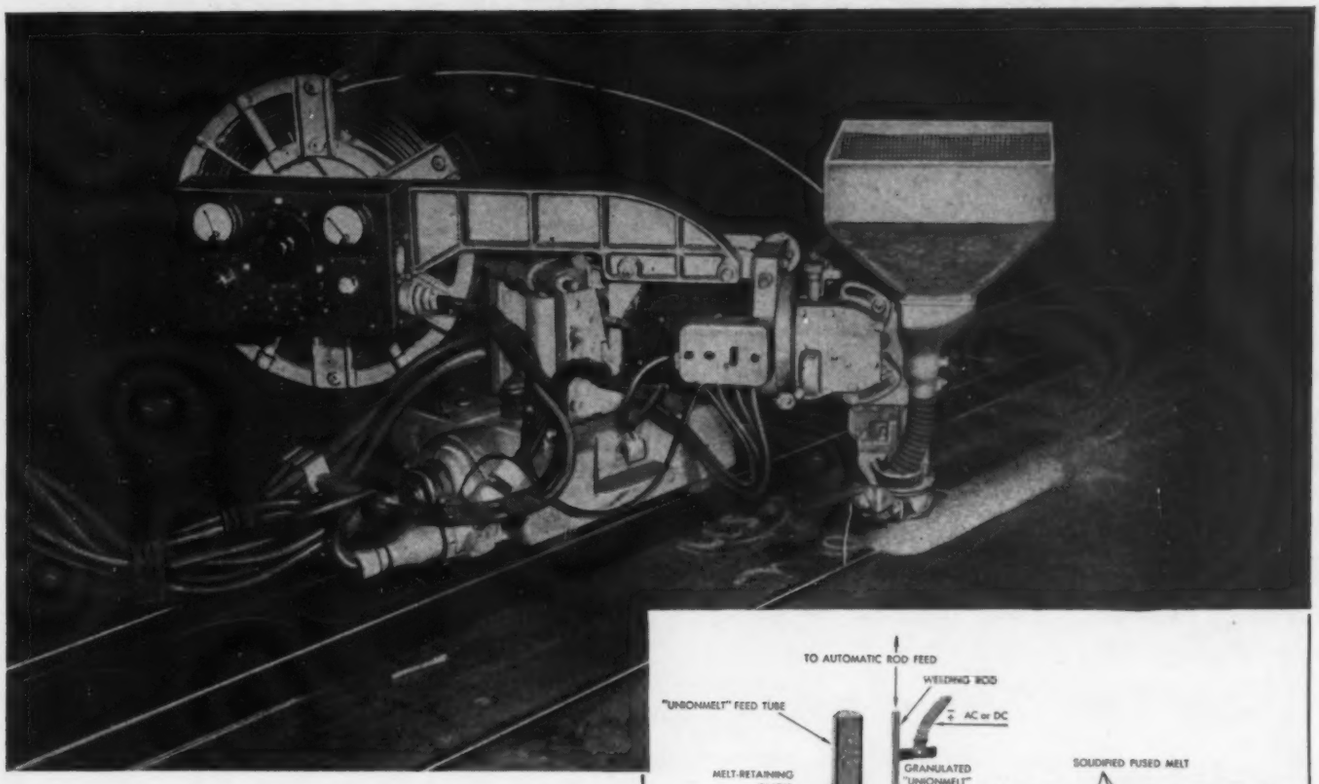
STEEL EQUIPMENT DIVISION OF **THE BONNOT COMPANY, CANTON, OHIO**

BONNOT

ENGINEERED FOR IMPROVED PRODUCTION

WRITE US FOR COMPLETE FACTS

UNIONMELT WELDING



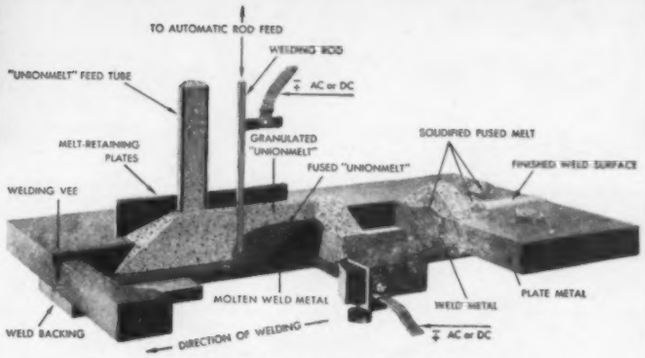
Linde's Automatic Electric Process

UNIONMELT electric welding joins steel of any commercially used thickness at speeds up to twenty times faster than similarly applicable methods. Because the process is automatic, it produces uniform welds of unusually high-quality with minimum dependence on the manual skill of welding operators.

The flexibility of UNIONMELT welding has led to its application for a wide variety of work—for heavy and light material, for repetitive operations or single jobs, and for shape-welding as well as for straight-line and circumferential welding.

Metal-fabricating shops of all kinds can profit by using the UNIONMELT process for either fabrication or repair work. If you are interested in learning more about this process, or in discussing its possibilities for any particular application, please write to us.

BUY UNITED STATES WAR BONDS



HOW IT WORKS

1. A special granulated material known as UNIONMELT is laid down along the seam to be welded so that it covers the end of the welding rod.

2. Heat, generated by passing an electric current through the UNIONMELT composition between the welding rod and the parts being welded, progressively melts some of the UNIONMELT so that it forms a protective blanket over the weld area.

3. Underneath this molten UNIONMELT composition, metal from the rod and from the plate edges are fused to form the weld.

4. The molten UNIONMELT cools and solidifies behind the welding zone and, on further cooling, contracts and detaches itself.

The process of welding electrically beneath a mineral melt by the method illustrated is patented.

The Linde Air Products Company
Unit of Union Carbide and Carbon Corporation

General Office, 30 E. 42nd St., New York 17, N. Y.
Offices in Other Principal Cities
In Canada: Dominion Oxygen Company, Limited, Toronto

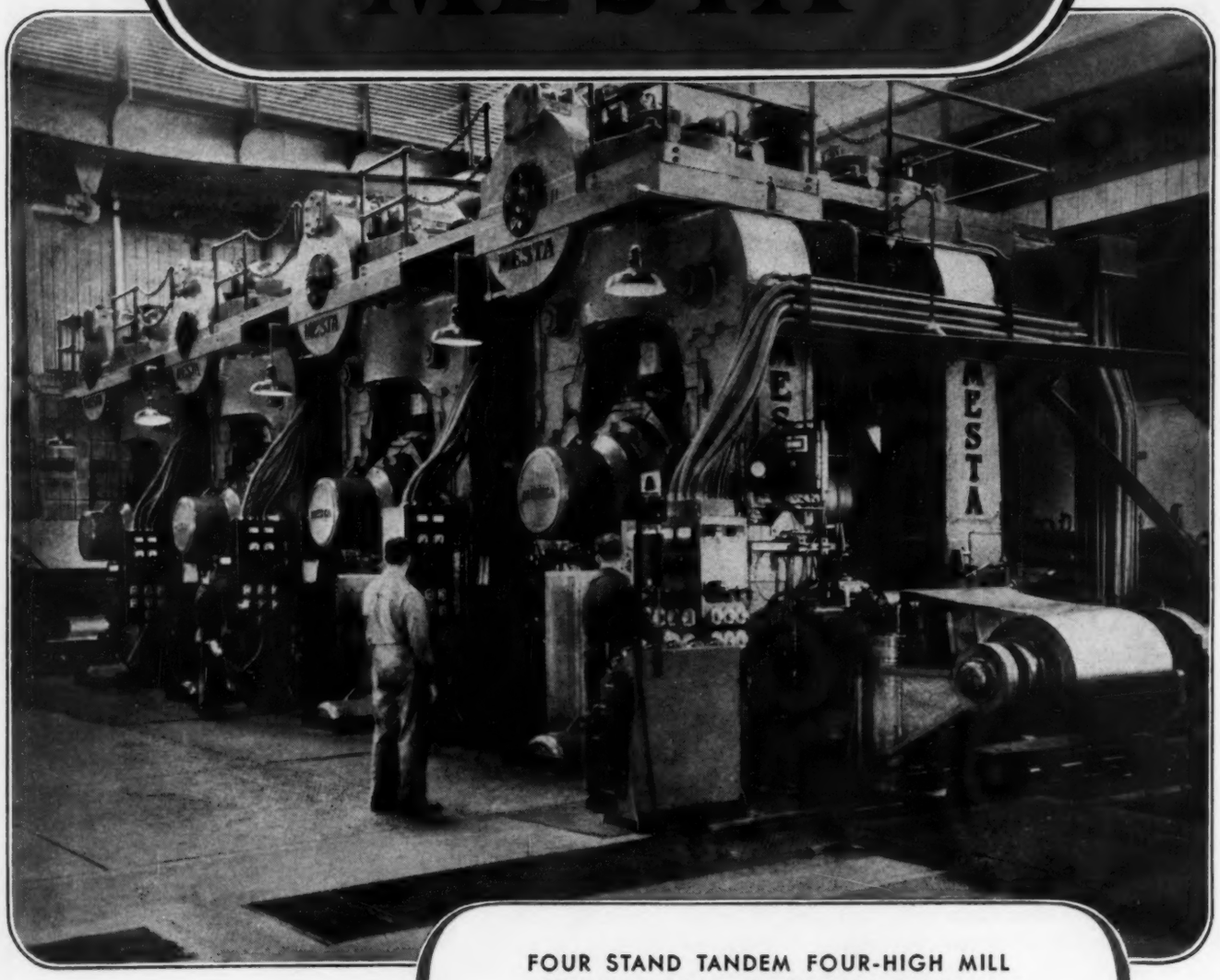
LINDE OXYGEN . . . PREST-O-LITE ACETYLENE . . . UNION CARBIDE
OXWELD, PUROX, PREST-O-WELD, UNIONMELT APPARATUS
OXWELD AND UNIONMELT SUPPLIES

The word "Unionmelt" is a registered trade-mark of The Linde Air Products Company

FOUR-HIGH COLD MILLS

Designed and Built by

MESTA



FOUR STAND TANDEM FOUR-HIGH MILL
FOR THE COLD REDUCTION OF THIN
SHEET STRIP AND GALVANIZING STOCK

The Army-Navy "E" Flag with four stars, flies over the Mesta Plant

MESTA MACHINE COMPANY
Pittsburgh, Pa.

Below: Section of a spill after removal from the open hearth building. Note type of material encountered.

Oxygen Lancing

BREAKS UP BIG FURNACE SPILLS IN RECORD TIME!

Clearing the ground for enlargement and repair of the open hearth department, a major steel producer ran into a number of large furnace spills that had to be moved before the furnaces could be erected. Some of them were five feet square by fifteen feet long and weighed 75 tons—too heavy for the charging floor crane to lift.

Breaking them up into pieces small enough to be handled looked like several weeks' job with serious delay in completion of the furnaces.

The problem was discussed with representatives of Airco's Applied Engineering Service Department. They recommended the use of the oxygen lance and furnished instructions for the difficult job of cutting through the mass of brick, slag, cinders and steel of which the spills were composed.

Result: Each five-foot square spill was cut in half in about 24 hours and many valuable days were saved.

This is a typical example of the practical service Airco provides to the steel industry—a service that begins at the ore mines and reaches through to the shipping docks—including periodic checks of mill operations seeking quicker, better and more economical ways of performing them.

You are invited to make use of this service on all matters involving the cutting and welding of metals and such applications of the oxyacetylene flame as scarfing, gouging, hardening and descaling. Just get in touch with the nearest Air Reduction sales office.

★ BUY UNITED STATES WAR BONDS ★

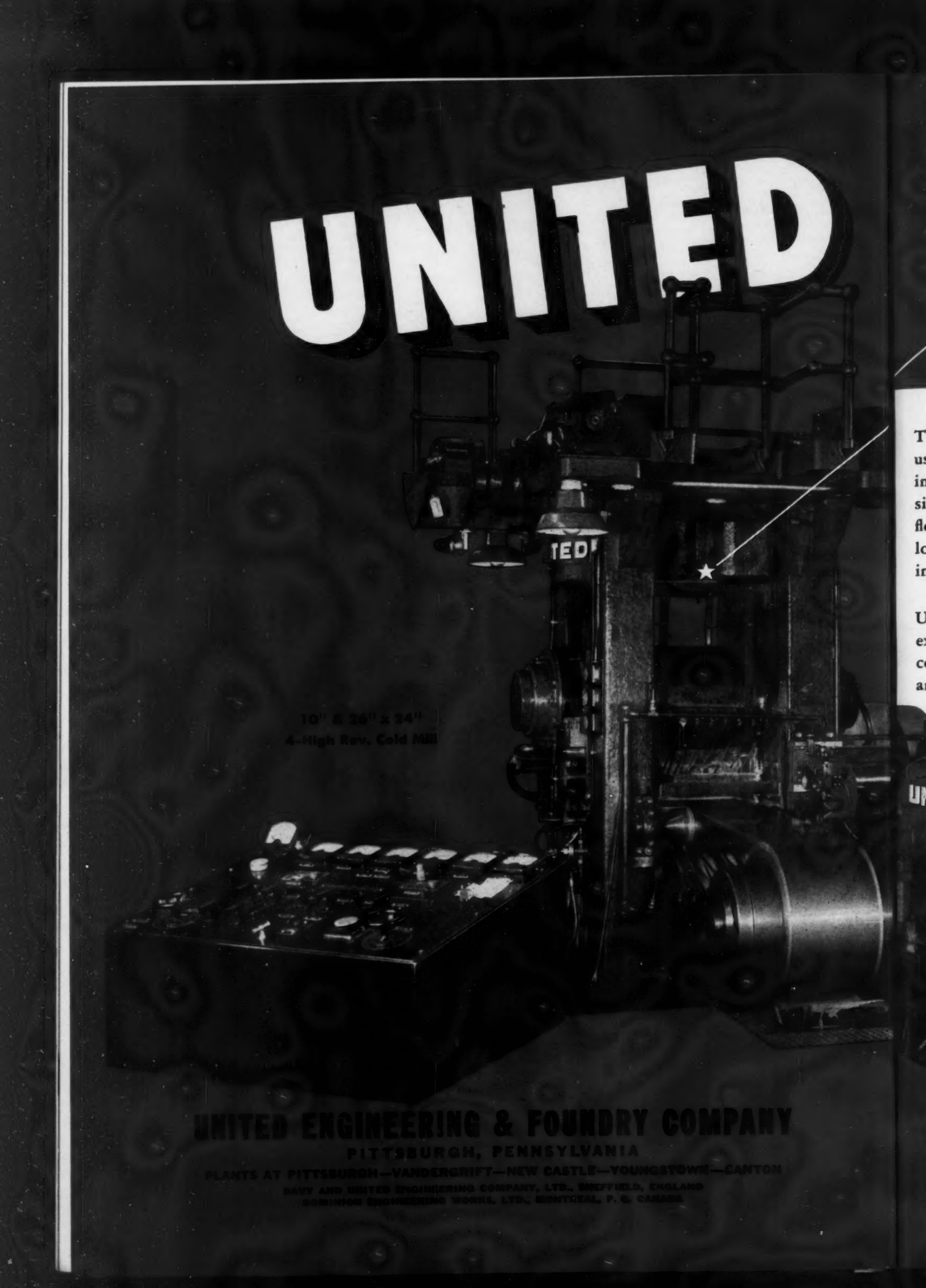
AIRCO

AIR REDUCTION

General Offices: 60 EAST 42nd STREET, NEW YORK 17, N. Y.

In Texas: MAGNOLIA AIRCO GAS PRODUCTS CO. • General Offices: HOUSTON 1, TEXAS

Offices in all Principal Cities



UNITED ENGINEERING & FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

PLANTS AT PITTSBURGH—VANDERGRIFT—NEW CASTLE—YOUNGSTOWN—CANTON

DAVY AND UNITED ENGINEERING COMPANY, LTD., SHEFFIELD, ENGLAND

DOMINION ENGINEERING WORKS, LTD., MONTREAL, P. Q. CANADA

4-High Precision Cold Mills

For Rolling Ferrous and Non-Ferrous Metals

These UNITED MILLS are used chiefly for accurate finishing of thin gauge strip. Their simplicity of design permits flexible speed operations at a low maintenance and operating cost.

They are a product of UNITED'S more than 40 years experience in the design and construction of rolling mills and their auxiliary equipment.

9½" & 22" x 12"
4-High Rev. Cold Mill

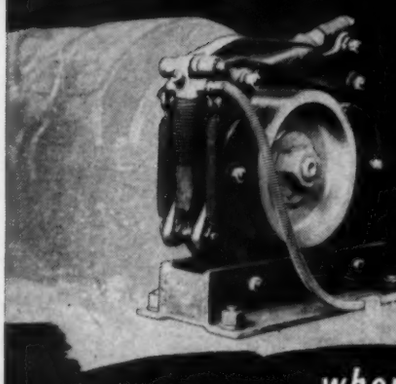
12½" & 37" x 34"
4-High Rev. Cold Mill

UEC&CO

R. C. T. M.

The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment

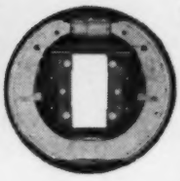
Use Wagner
INDUSTRIAL BRAKE CONTROLS



wherever industrial machinery must be stopped quickly, safely, and smoothly

A typical crane bridge-braking system as used on overhead cranes is illustrated. It consists of an external brake, which is actuated by a foot-operated master cylinder. The same system has been successfully applied to other machines, such as bending-rolls, scrap-balers, large wheel-balancers, and similar applications depending on foot pressure to decelerate the machine for either normal or emergency stops.

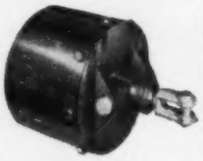
Wagner manufactures many other brake controls which may be applicable to your machines. These may be either air or hydraulically actuated. A general idea as to what these controls are may be obtained by referring to the illustrations shown on this page. However, types of applications for dependable brake control are numerous and very often difficult to determine. We suggest that you consult us and benefit by the recommendations of our trained and experienced brake engineers.



TYPICAL WAGNER LOCKHEED INTERNAL BRAKE

A typical Wagner Lockheed internal brake assembly. Available in various sizes for application to some types of industrial machinery. Wagner engineers will advise you whether this type of brake can be applied to your machinery.

AIR CYLINDER

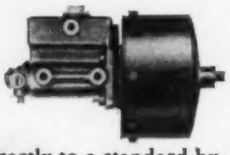


This Wagner air power-cylinder assembly converts the energy contained in compressed air into mechanical force, which (through linkage) expands the brake shoes in mechanical brake systems or actuates the hydraulic master-cylinder in air-hydraulic brake systems.

HYDRAULIC ACTUATOR CYLINDER

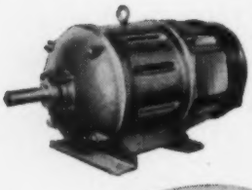
One of several types of hydraulic actuating-cylinders which transforms the hydraulic-fluid pressure into the mechanical force needed to apply the brake shoe against the brake wheel or drum.

POWER CLUSTER



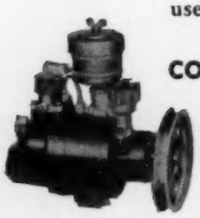
The Wagner Power Cluster simplifies the application of air power to hydraulic brake systems. It consists of a standard air power-cylinder assembled directly to a standard hydraulic master-cylinder. It produces desired hydraulic line-pressure by varying the air pressure without the use of levers or linkage.

MOTOR and BRAKE UNIT



Each unit is equipped with an internal expanding shoe-type brake that is applied by hydraulic pressure developed in a foot-operated master-cylinder.

AIR COMPRESSOR



The function of this unit is to develop and maintain sufficient compressed air in air reservoir to operate air-brake system and other air-powered accessories.

TYPE HM BRAKE

Wagner Type HM Hydraulic Industrial Brake is intended for use on overhead cranes, whirler cranes, coke pushers, lorry cars, door machines, and transfer cars which require a parking brake when out of service or while performing their principal functions.

Foot-controlled master-cylinder

TELL US YOUR PROBLEMS

144-13

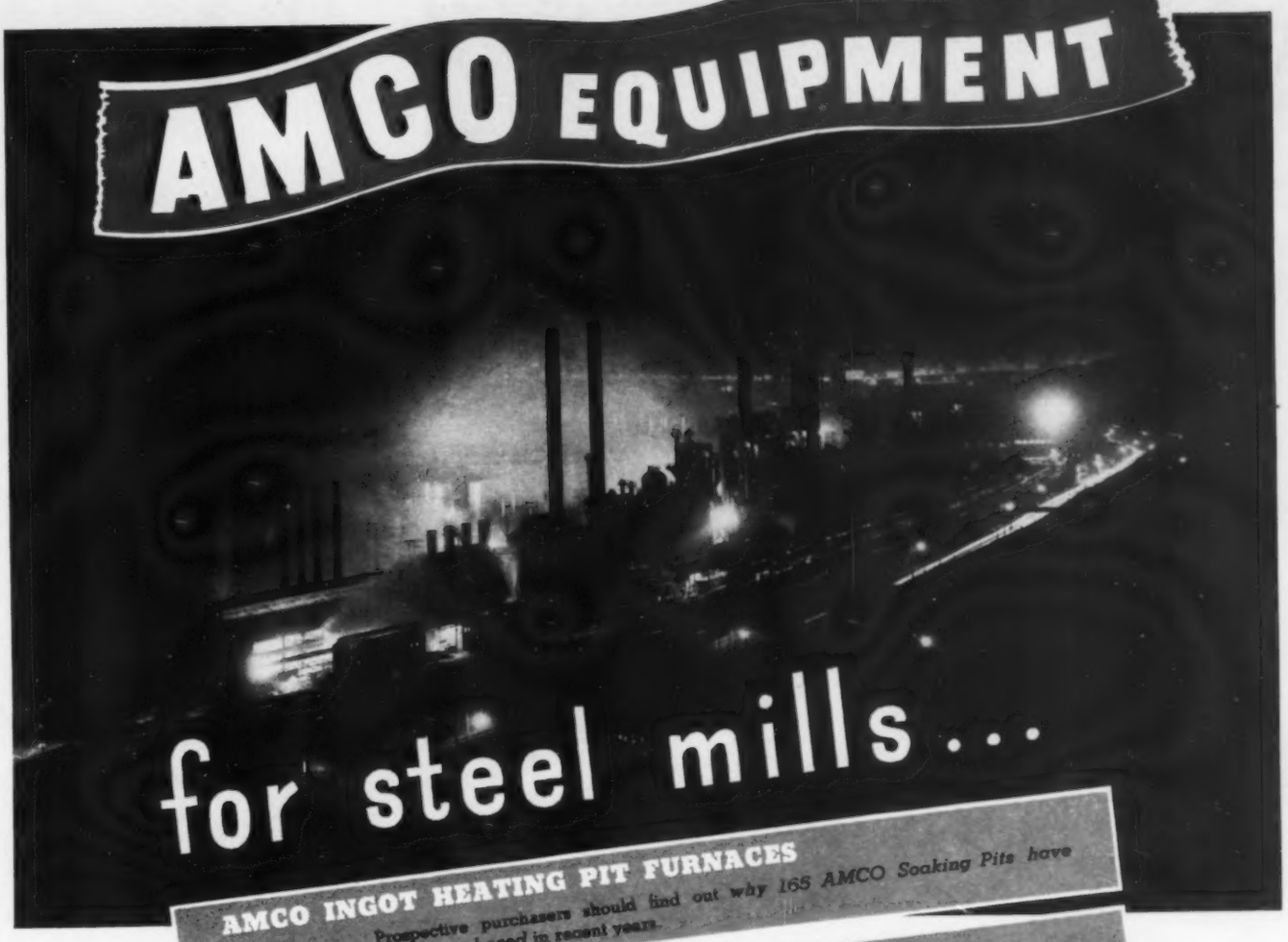
Wagner Electric Corporation

ESTABLISHED 1891

6483 Plymouth Avenue, St. Louis 14, Mo., U. S. A.

ELECTRICAL AND AUTOMOTIVE PRODUCTS

AMCO EQUIPMENT



for steel mills . . .

AMCO INGOT HEATING PIT FURNACES
Prospective purchasers should find out *why 165 AMCO Soaking Pits have been purchased* in recent years.

AMCO SIDE DOOR HEATING FURNACES
For reheating plate and forging ingots, slabs, and billets of all sizes—continuous doors where desirable.

AMCO CONTINUOUS PUSHER TYPE FURNACES
For reheating slabs and billets. Ingots *up to 17" thickness* successfully heated in charging-end fired furnaces.

AMCO ALL REFRACTORY RECUPERATORS
More than 600 AMCO Recuperators installed in the steel industry during the past 8 years; preheated air temperatures up to within 700° F. of waste products temperatures.

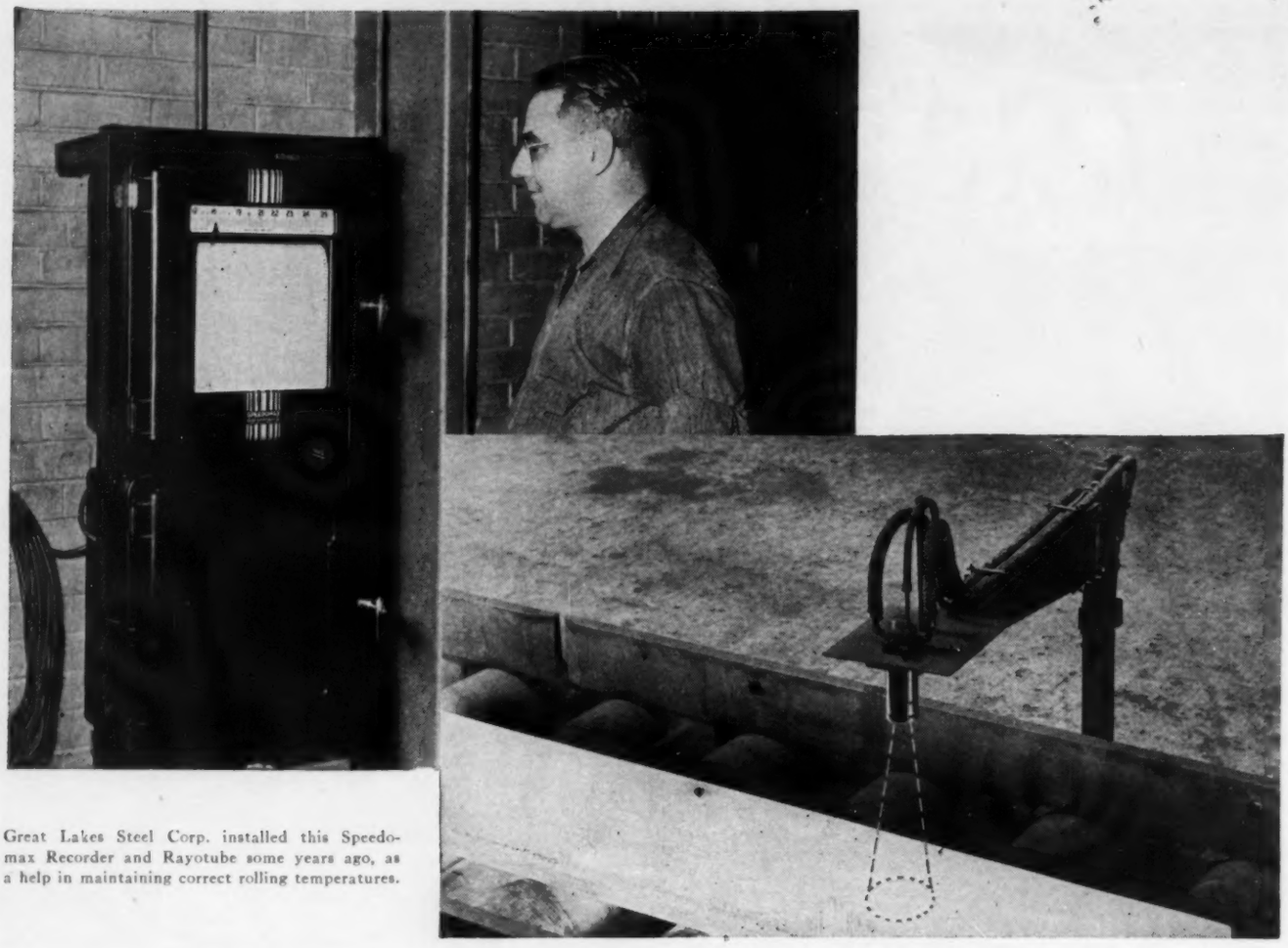
AMCO OPEN HEARTH FURNACES
All sizes and types, complete with full automatic control and reversing.

AMCO PULVERIZED COAL SYSTEMS
Including long distance transport—for all types of industrial reheating furnaces.

AMCO ENGINEERING AND CONSTRUCTION SERVICE
Inquiries solicited for redesigning, rebuilding, relocating furnaces; dismantling, moving, erecting other heavy equipment.

The AMSLER-MORTON Company
FULTON BUILDING · PITTSBURGH, PA.

5



Great Lakes Steel Corp. installed this Speedomax Recorder and Rayotube some years ago, as a help in maintaining correct rolling temperatures.

"GREAT LAKES" Catches Temperature On The Fly--with Speedomax Recorders

"The billet was rolled too cold (or too hot)" is a report which we are told is seldom made in the mill where the above-shown Speedomax Recorder is used. And the reason is obvious; the Speedomax not only measures the temperature but records it, and everyone concerned knows all about the record. It bridges the gap of information which previously existed between the record of furnace temperature (kept by Micromax Recording Controllers) and the metallurgical department's Optical-Pyrometers checks. And Speedomax can be used anywhere in this gap — at any pass from the roughing mill to the last stage in the rolling of rod, rail, strip or plate. It helps heaters and rollers cooperate to put every billet through at the specified temperature.

The equipment consists of the vacuum-tube Speedomax Recorder itself, and a Rayotube radiation-detecting thermopile which, for all its high sensitivity, is enormously sturdy. In fact, the first detail which steel mill men notice about Speedomax is its absolute indifference to vibration and even position. It can be installed anywhere in the mill, and requires no more care than a Micromax thermocouple pyrometer.

Many temperature ranges are available, one of the most popular being 1200-2500, as shown above. If you would be interested in further information, an L&N engineer will gladly work on a specific application, or send you a catalog as you prefer.

depends on me!
A Slogan For Every American

Jrl Ad N-33B-685 (1)

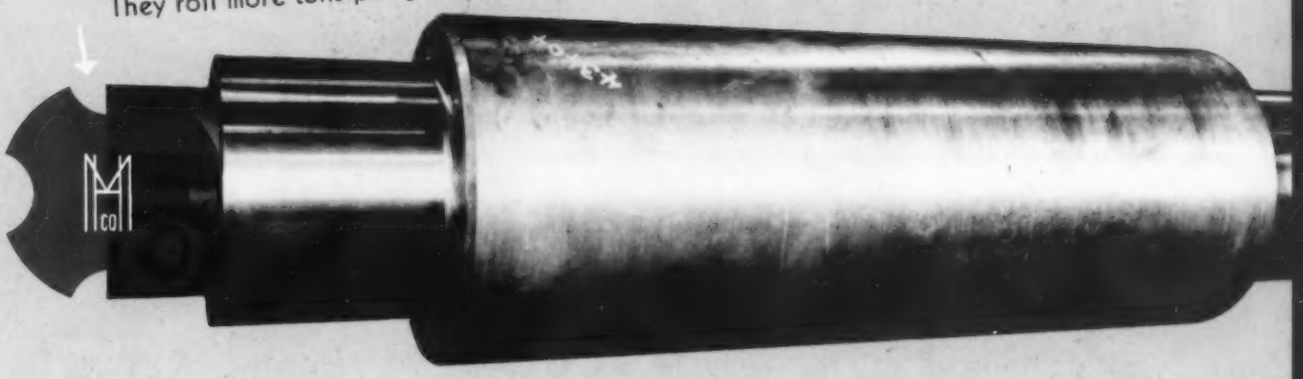
LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

The roll with the red wabblers

They roll more tons per grind



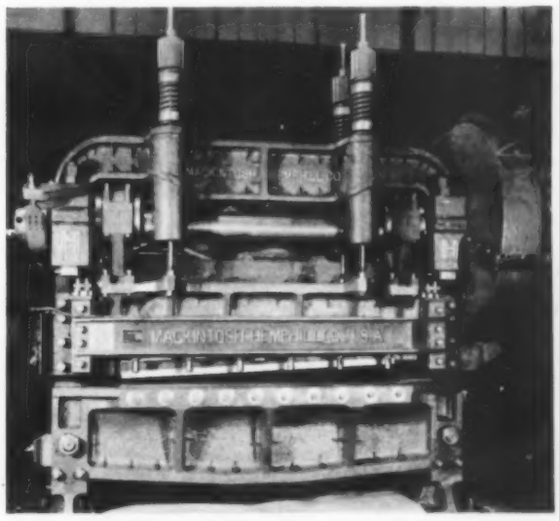
IS YOUR EYE ON QUALITY ?

ARE YOU THINKING about tomorrow's competition? Maybe you can gain the desired marketing advantage by improving the quality of your product . . . or perhaps, increased output or decreased production costs may be your answer? . . . To such problems, Mackintosh-Hemphill brings you a proved source of *advanced* industrial thinking. In the metallurgical, engineering and manufacturing end of heavy duty equipment, they offer you a complete, *balanced* service that has been an important business help to other manufacturers. For example, M-H plate rolls and shears have established new production records in dozens of plants—upped the tonnage—cut its cost—and substantially increased product quality. Write for proof of these facts.

MACKINTOSH-HEMPHILL CO.

Pittsburgh and Midland, Penna.

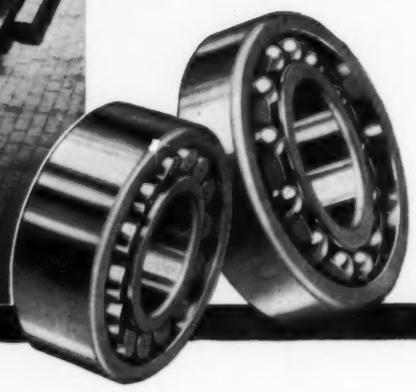
EXPERIENCE FOR SALE—Mackintosh-Hemphill's experience has been accumulating for 140 years. It is the solid foundation upon which present, progressive M-H technical minds have built their international reputation for successful industrial leadership. Today its benefits are available to you through their cooperative consulting service on the mechanical engineering end of industrial production equipment.



It takes quality to make quality. M-H plate rolls whether Nironite, Plain or Molybdenum Chill quality deliver a better finish—M-H shears assure cleaner cuts. Together they put plate production on the highest efficiency basis.

OTHER PRODUCTS: *Rolling Machinery . . . Shape Straighteners . . . Strip Coilers . . . Shears . . . Levellers . . . Pinions . . . Special Equipment . . . Iron-Steel Castings . . . The NEW Abramsen Straightener . . . Improved Johnston Patented Corrugated Cinder Pots and Supports . . . Heavy Duty Engine Lathes.*

Built by
TREADWELL
ENGINEERING CO.



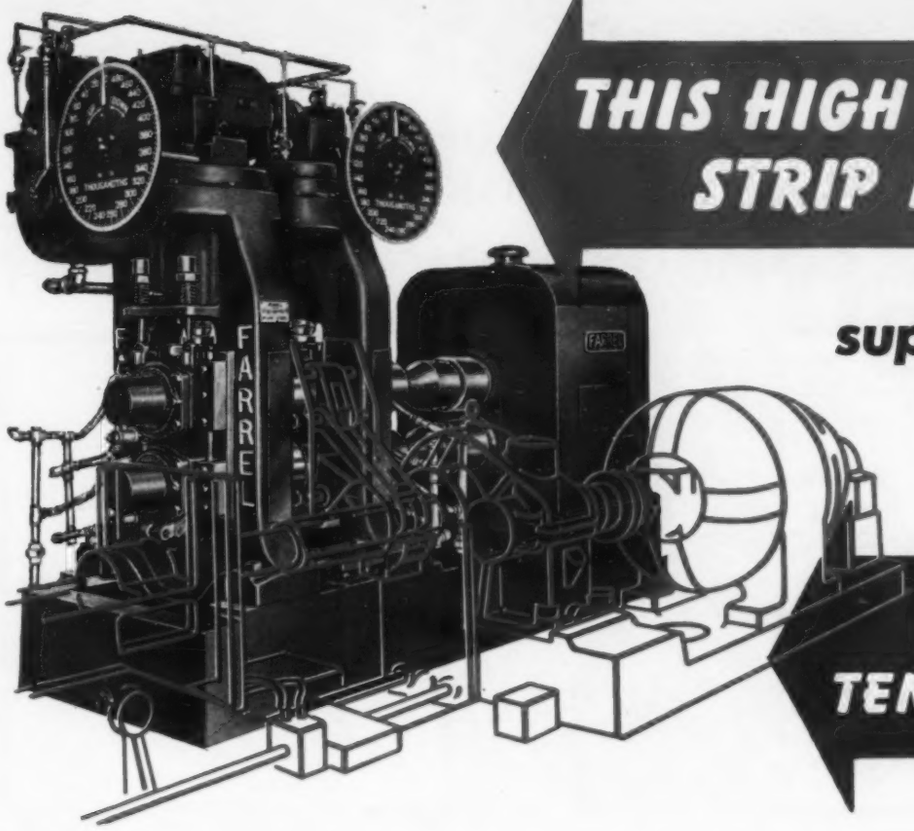
Push production up *with* SKF *Bearings*

Machines must run *continuously* if steel is to flow freely from furnaces to guns, ships, tanks and other vital weapons. Not the least important of these machines are table rollers which, protected by SKF's, have little difficulty in staying up with tight production schedules. Self-aligning characteristics of SKF Spherical Roller Bearings compensate for inaccurate setups, shaft deflections, distortions or weave without binding. Full capacity is always available for useful work. Bearing trouble is eliminated. All advantages that enable SKF's to keep steel rolling steadily on machines of all kinds. 5672

SKF INDUSTRIES, INC., PHILA. 34, PA.

SKF

ball and roller bearings



THIS HIGH CARBON STRIP MILL

supplied either with or without a

CONSTANT TENSION COILER

THE MILL

The mill itself is specially designed to provide high accuracy of gauge in continuous, high-speed cold rolling of strip. Duplex control of the built-in screwdown is provided so that the screws can be operated independently or in synchronism through magnetic clutches. Design of the screwdown permits adjustment of gauge under full load.

Rolls, which are of forged alloy steel, heat-treated and hardened, are carried in precision-type, flood-lubricated sleeve bearings. They are connected to the pinion stand with universal spindles. The mill is driven by an adjustable-speed reversing motor through a Farrel combined gear unit and pinion stand.

THE COILER

The coiler consists of an enclosed herringbone gear reduction unit with the low speed shaft extended in the form of a spindle on which either a solid or collapsible reel is rotated for winding the strip. A jaw or belt type wrapper, stripper and up-ender can be supplied.

Constant tension, under positive control from empty to full reel, is accomplished by automatic regulation of current input to the motor. All controls are conveniently located within easy reach of the operator.

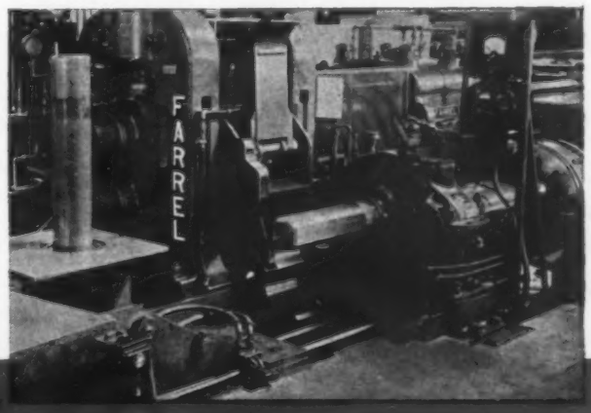
ENGINEERING SERVICE

Farrel rolling mills for sheets, rods or strips are designed to suit individual conditions of operation. Various types of coilers are built to fit specific requirements of new or existing mills of any size or make.

An experienced engineering staff is prepared to assist you in selecting mills and coilers for the solution of your production problems.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.

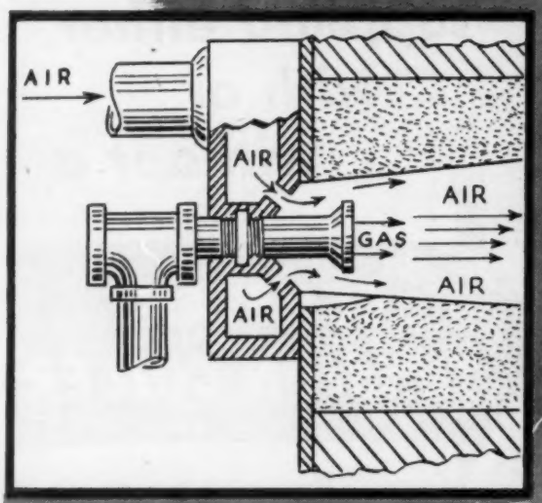
Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Pittsburgh, Akron, Los Angeles



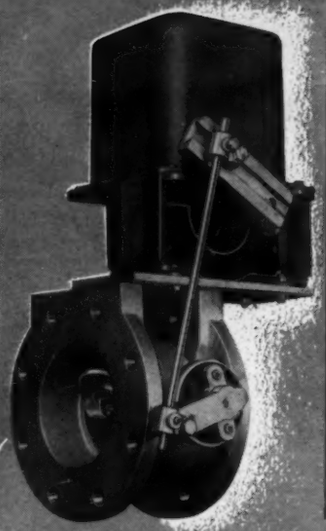
Farrel-Birmingham

BLOOM

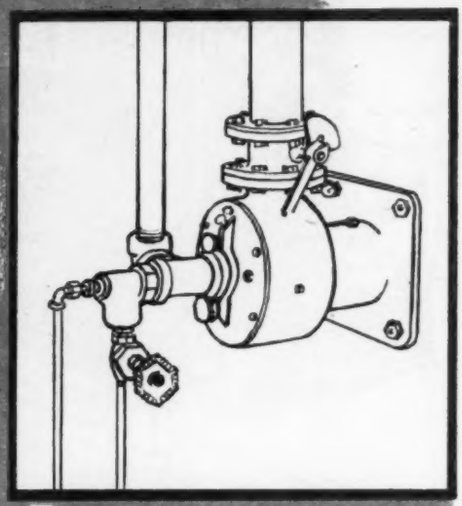
. . . engineers . . . designers and builders of dependable INDUSTRIAL COMBUSTION EQUIPMENT



Tempered-Flame Burners for economical Controlled Heating and Cooling Cycles



Leeds Northrup motor operated, through shaft Gas Butterfly Valves



Long Flame Burner, permits change from gas to oil, oil to gas without shutdowns or delays

Bloom engineers are always glad to analyze your combustion problems and suggest uses for the new developments, and improved methods of heat control. As designers and builders of economical, dependable burners and other combustion equipment, utilizing all types of fuel—Bloom is not committed to any one fuel or method of operation—except that which will do your job best. Technical bulletins are available on all equipment listed below—write today.

BLOOM ENGINEERED EQUIPMENT

Tempered-Flame Burners · Long Flame Burners · Multiple Jet Type Oil Burners · Combination Gas and Oil Burners · Emulsion Type Oil Burners · Nozzle Mix Burners · Blast Gates · Unit Oil Atomizer Burners Manual Butterfly Valves · Automatic Butterfly Valves · Raw Producer Gas Burners Fuel Oil Regulating Valves · Air Control Valves · Hot Air Burners · Clean Producer Gas Burners · Differential Oil Flow Control Valves · Pressure-Balancing Ratio Regulators · and many other types of standard or specially designed equipment for regular fuels or standby conversion fuels.

BLOOM EQUIPMENT APPLICATIONS

Open Hearths · Metal Mixers · Soaking Pits · Slab and Billet Reheating Furnaces · Annealing Operations · Forge Furnaces · Melting Furnaces · Air Furnaces · Core Ovens · and in every other manufacturing process where controlled heat is vital to successful low cost operations.

BLOOM Engineering Co.
857 W. NORTH AVENUE
PITTSBURGH 12, PENNA.

Salem CIRCULAR SOAKING PIT

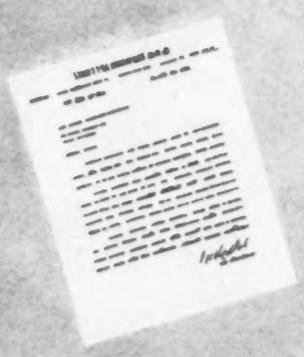
for better ingot heating

Being of circular shape, which eliminates cold corners, you can heat more ingots per square foot of occupied floor space and heat them MORE UNIFORMLY with Salem Soaking Pits.

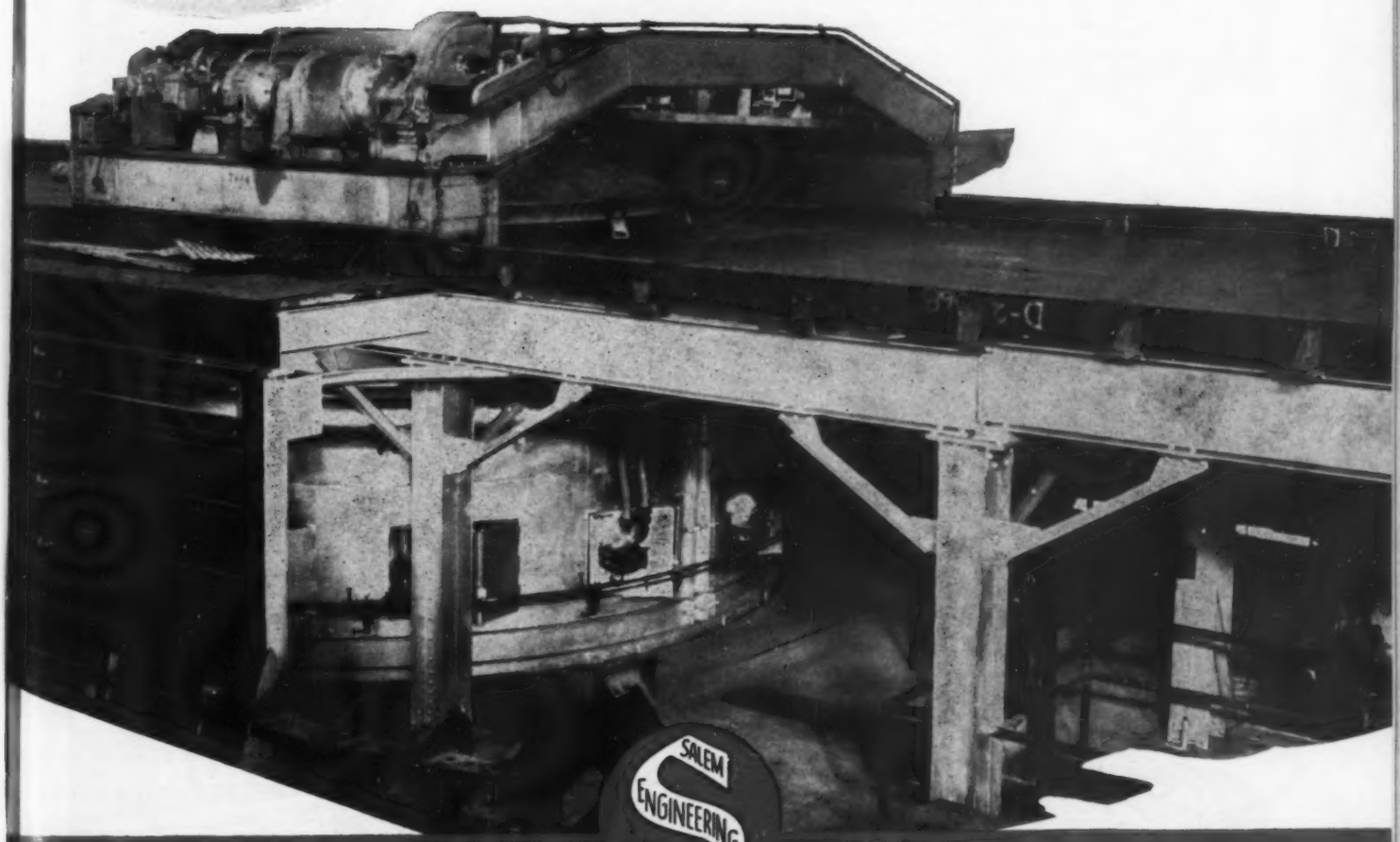
Heat is obtained from a multiplicity of oil or gas burners. The hot gases flow into the pit at a tangent to the circular wall of the furnace, causing the gases to follow a circular path. There is no flame impingement on the furnace wall or the steel, and all ingots are heated uniformly from top to bottom. This method of firing results in a 25% faster heating cycle.

Salem builds the circular pit in diameters between 8′ and 20′ utilizing all types of fuel.

If you want to improve your conditioning costs, investigate the Salem Circular Pit.



Prompt Attention to Your Circular Soaking Pit Inquiry



SALEM ENGINEERING COMPANY

SALEM ENGINEERING CO.

SALEM, OHIO

Those roaring overtones and undertones—just deafening noise to unpracticed ears—blend into the symphony of steel you know so well. The faintest dissonance—the slightest offbeat—means trouble somewhere in the mill.

Taking heavy punishment day and night, N-B-M Steel Mill Bearings and Castings play a vital part in maintaining the rhythm of the rolls—keeping your steel song steady, strong.

Seventy years of specialization are your guarantee of satisfaction when you specify

N·B·M

BRONZE AND COPPER CASTINGS

Blast Furnace Copper Castings • Roll Neck Bearings
Housing Nuts • Machinery Castings • Acid Resisting
Castings • Phosphorized Copper • Babbit Metal

NBM

NATIONAL BEARING METALS CORPORATION

ST. LOUIS • NEW YORK

AMERICAN Brake Shoe COMPANY

Plants in: St. Louis, Mo. • Pittsburgh, Pa. • Meadville, Pa. • Jersey City, N. J. • Portsmouth, Va. • St. Paul, Minn. • Chicago, Ill.

Alliance

WORLD'S LARGEST BUILDERS OF THE WORLD'S LARGEST CRANES

A shop view of the complete bridge structure of a 300-ton hydraulic forging crane of 100′0″ span.

Incorporated in the design of the welded steel girders for this crane is the application of horizontal stiffeners in combination with thin web plates. This design reduces the total weight of the girder without sacrificing strength. A further reduction in the weight of these girders without sacrificing strength resulted from the use of nickel-copper steel which permitted an allowable stress of 24,000 pounds p. s. i.

These are the largest capacity welded girders ever built and emphasize our slogan, "the world's largest builders of the world's largest cranes."

Since 1901, the steel industry has looked to Alliance, not only for large capacity overhead cranes but for such equipment as the following:

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES OPEN HEARTH CHARGING MACHINES

THE ALLIANCE MACHINE COMPANY • ALLIANCE, OHIO

PITTSBURGH OFFICE : 1622 OLIVER BUILDING

NORTH AMERICAN
SAFETY SHUTOFF VALVES
WILL CLOSE FUEL SUPPLY

●

WHENEVER
ANYONE SHUTS OFF AIR SUPPLY

●

WHENEVER
FUEL OR AIR PRESSURE FAILS

●

WHENEVER POWER FAILS

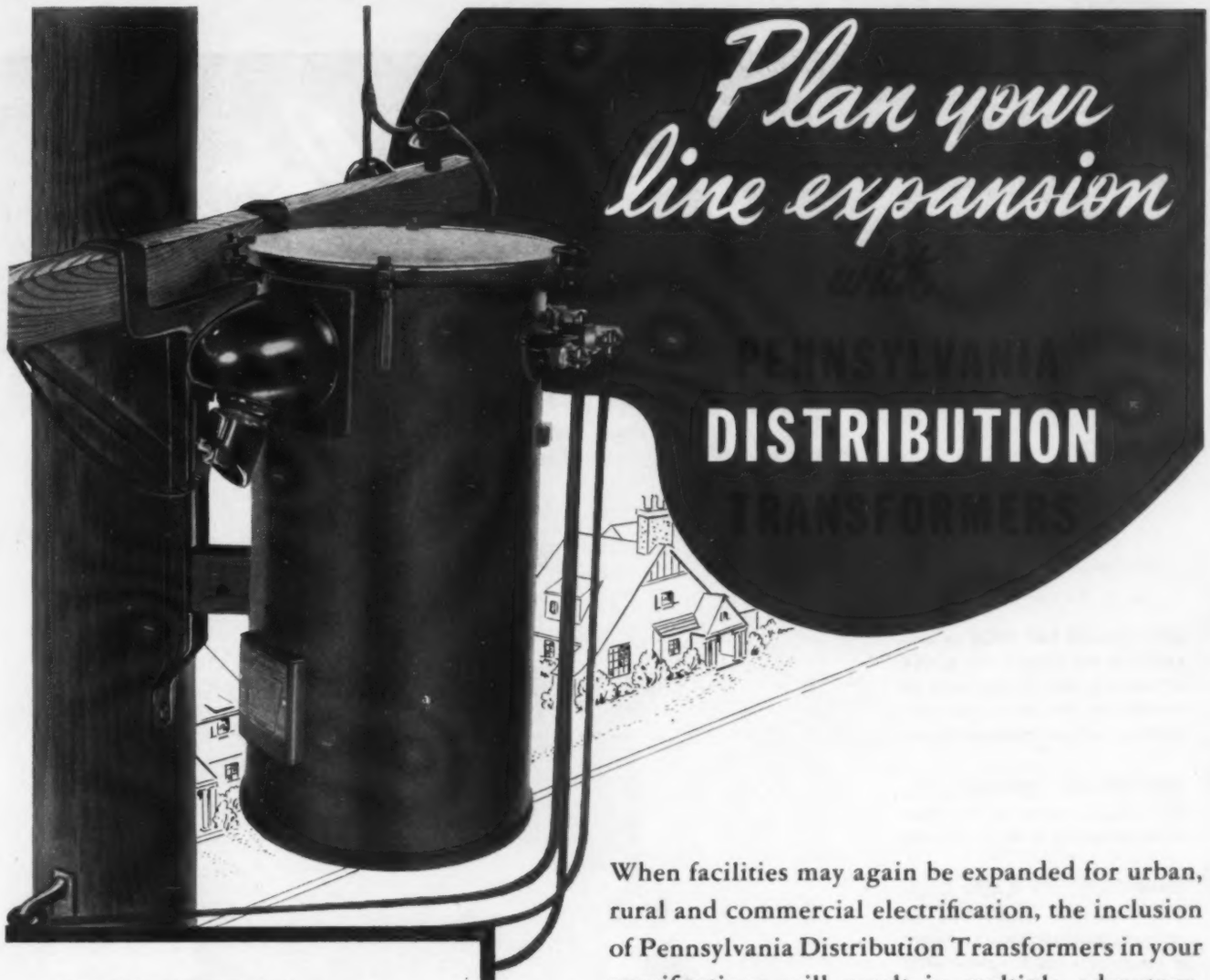
★

ONCE CLOSED THE VALVE MUST BE RESET MANUALLY, GIVING THE OPERATOR TIME TO CHECK THE TROUBLE AND PREPARE FOR PROPER RELIGHTING OF BURNERS

★

SIMPLE COMPACT DESIGN GUARANTEES DEPENDABLE OPERATION

THE NORTH AMERICAN MANUFACTURING COMPANY
MANUFACTURERS OF INDUSTRIAL FUEL BURNING EQUIPMENT FOR GAS OR OIL
BRANCH OFFICES *with* FIELD ENGINEERS *in* PRINCIPAL CITIES
CLEVELAND 4, OHIO



Plan your line expansion

with PENNSYLVANIA DISTRIBUTION TRANSFORMERS

When facilities may again be expanded for urban, rural and commercial electrification, the inclusion of Pennsylvania Distribution Transformers in your specifications will result in multiple advantage. *Pennsylvanias* have won an enviable reputation for reliable performance, exceptionally low operating cost, reduced upkeep and long life.

These qualities have been clearly demonstrated in a period when maximum loads with minimum maintenance have been the rule rather than the exception. The outstandingly successful performance record of Pennsylvania Distribution Transformers results from a combination of advanced design features, coupled with quality materials, workmanship and specialization.

Plan with Pennsylvanias. *Pick Pennsylvanias for Performance.*

"PENNSYLVANIAS" *give you these superior features..*

- Circular Coils for maximum strength and balanced stresses.
- Low temperature varnish impregnation maintains pliable insulation.
- Oversize pockets to protect high voltage bushings.
- Round tanks with permanently tight lock-seam Welded bottoms.
- Easily detachable, wet-process porcelain bushings.
- Built up core laminations of high grade silicon steel.
- Coil easily and quickly removable from core if necessary.
- Extra-sturdy lift lugs and support lugs.
- Shot blasting prepares surface for one coat of red primer and two finish paint coats.

Pennsylvania Transformer Company

808 RIDGE AVENUE N. S. PITTSBURGH 12, PA.

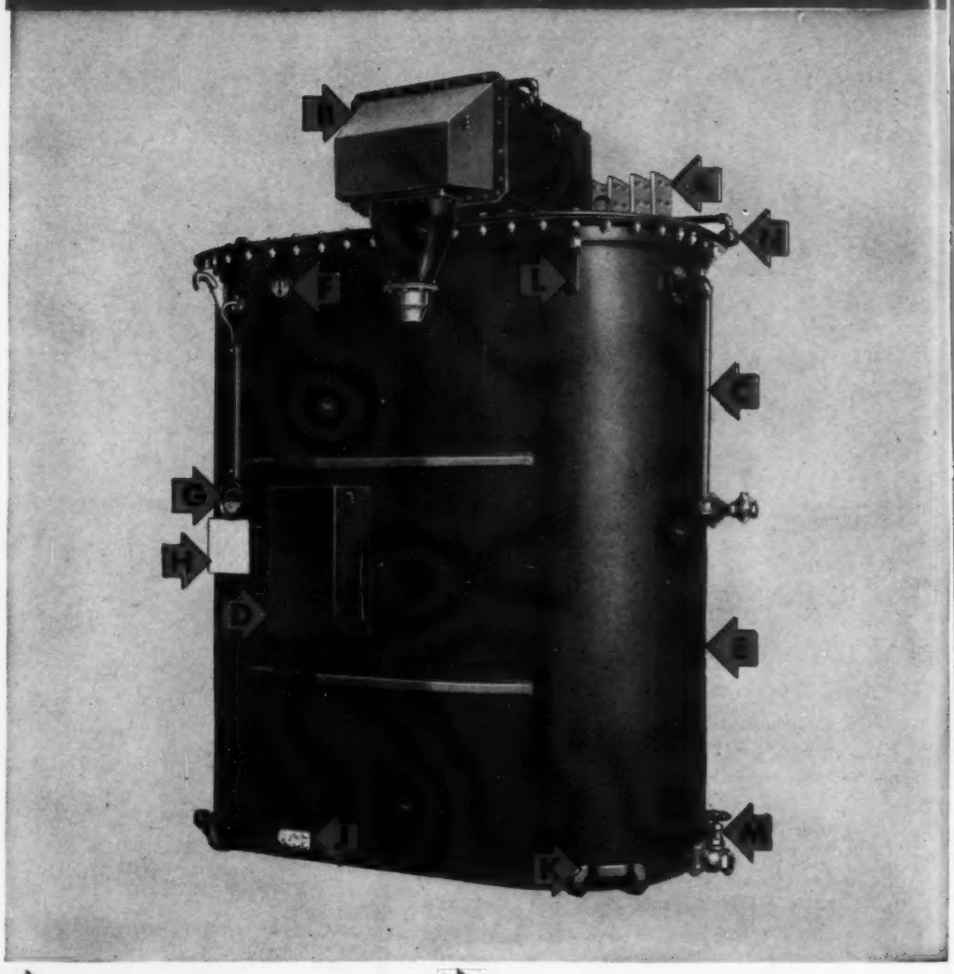
Pennsylvania TRANSFORMERS

ARC-FURNACE TRANSFORMERS

Built to

OUTSIDE

Typical three-phase, water-cooled G-E furnace transformer showing location of standard accessories



A LOW-VOLTAGE BAR LEADS for connection to the furnace, are located as near the edge of the cover as possible, so that the furnace connections can be of minimum length.

B HIGH-VOLTAGE JUNCTION BOX, for cable connection or for direct throat connection to the switchgear.

C CONNECTIONS FOR WATER COOLING. Since these transformers are generally installed indoors adjacent to the furnace, in a high ambient temperature, this method of cooling is the most effective. Water is circulated through a copper cooling coil inside the tank near the top liquid level.

D MOTOR-OPERATED, NO-LOAD VOLTAGE CONTROL reduces the time required to change winding-tap connections, thus saving time for the furnace operator and permitting more continuity of power input during the heat cycle.

E THE TANK is of welded-steel construction, thoroughly pressure-tested to assure freedom from liquid leaks.

STANDARD ACCESSORIES INCLUDE:

F Liquid-level gage with low-level alarm contacts

G Dial-type liquid thermometer with alarm contacts

H Diagrammatic nameplate with complete information on operating connections.

J Tank-grounding terminal

K Jack bosses

L Lifting lugs

M Drain valve with integral liquid-sampling valve

N Weatherproof ventilators

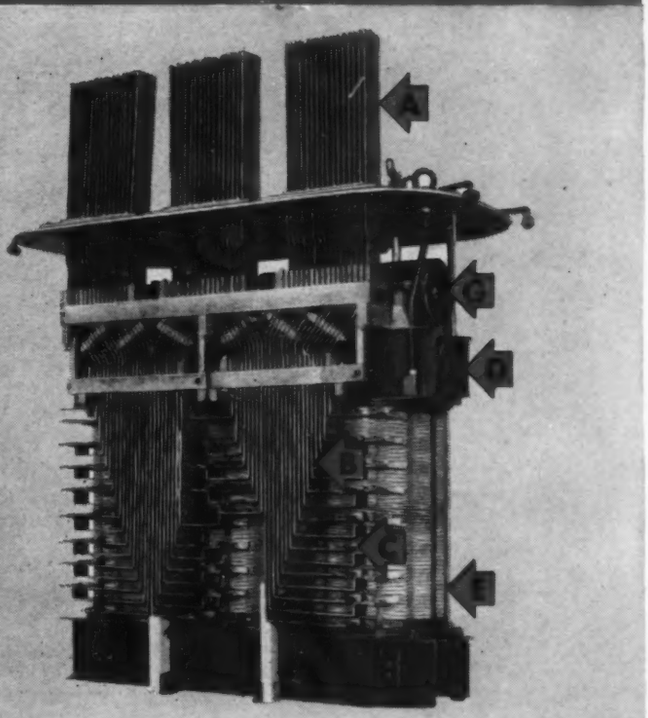
GENERAL ELECTRIC

854-29-7300

take a beating

YOU can depend on G-E arc-furnace transformers to give you *dependable* performance because they are designed and built to stand up under the severe service of arc-furnace operation. Here are some of the features that make these transformers outstanding for their operating convenience and low maintenance, as well as their durability:

INSIDE Oil-immersed, water-cooled, 3-phase furnace transformer, 9000 kva, 11,000 to 160 volts (Low-voltage side)



A **LOW-VOLTAGE LEADS** are solid bars of copper, amply proportioned and properly interleaved to minimize stray losses.

B **CONNECTIONS TO LOW-VOLTAGE WINDINGS** are solid-copper rods or bars, adequately braced to prevent distortion under short-circuit stresses.

C **WINDING AND TERMINAL CONNECTIONS** are electrically brazed, to prevent them from opening under heat, shock, or vibration.

D **VERTICAL-TYPE CORE** forms a firm foundation for the circular coils, which are wound on strong insulating cylinders.

E **CONCENTRIC CIRCULAR-COIL WINDINGS** are arranged with the high voltage next to the core, and the low voltage on the outside. Thus, simple connections can be made from the low-voltage coils to the bar leads.

TERMINAL BOARD, easily accessible under manhole opening in cover, provides preselection of operating taps to give the desired voltages and reactances for correct furnace operation.

G **WEDGE-TYPE RATIO ADJUSTERS,** arranged for external motor drive, provide a convenient means for changing the voltages and reactances during the heating cycle. Self-aligning contacts have high current-carrying capacity with low temperature rise.

TAPPED REACTOR gives additional adjustable reactance for control of arc stability, current, and power factor.

CURRENT TRANSFORMERS, for relaying and control, can be mounted within the tank for safety and for simplicity of arrangement.

There is a G-E power transformer of the proper size for every size of arc furnace. For more information, ask for Bulletin GEA-4246. General Electric Company, Schenectady 5, N. Y.

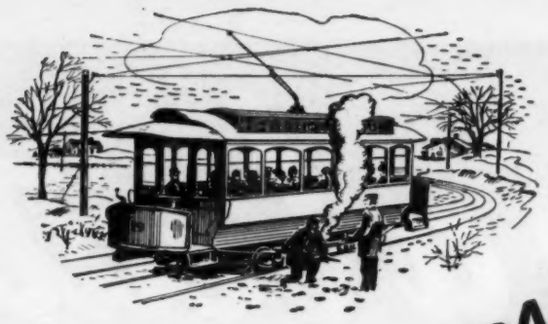
Add these co-ordinated units to complete a top-performance installation

Amplidyne control **provides a degree of accuracy and of high-speed response that is not equalled by any conventional type of control. Fast, smooth electrode operation, together with instantaneous corrective action, permits current to be maintained under changing furnace conditions. In addition, the unique amplidyne requires no continually operating contactors and relays and, therefore, requires comparatively little maintenance.**

Metal-clad switchgear, **with easily removable magne-blast circuit breakers, provides dependable protection for repetitive switching and, at the same time, reduces the inspection and maintenance requirements. This switchgear is shipped to you completely assembled—ready to install. Because of its completeness, compactness, and ease with which it can be installed, it provides the logical way to assure safe switching at low cost.**

Buy all the BONDS you can—and *keep all you buy*

Electric street cars of the 1880's used copper brushes... brushes that sparked, melted, cut grooves in commutators and ruined armatures. Engineers were baffled. The future of electric traction looked black. Then someone thought of the *carbon* brush!



THEY GAVE AMERICA THE CLEAR-TRACK SIGNAL!

That brilliant experiment with carbon, plus years of research by National Carbon Company, Inc., made possible the modern brush of high performance... typified in the Pennsylvania's crack "Congressional Limited" which averages 172 round trips from New York to Washington, D. C., on a single set of brushes.

CARBON BRUSHES made the halting electric street cars of the 1880's a success . . . giving the clear-track signal—the railroader's "green board"—for development of the magnificent electric locomotives of today!

Today, as for decades, "National" brushes serve most of the Nation's electric railroad and traction systems . . . typical of the enduring leadership they have earned *in every field.*

For wherever utmost dependability and efficiency are sought, "National" brushes are preferred. They're giving the "green board" to generators, motors, converters, and other types of rotating electrical equipment used by power companies, mines, mills, factories, chemical plants, transportation and communications systems, farms, homes, and most of the machines of war.

"National" brushes—carbon, graphite, electro-graphitic, and metal-graphite—are made in a series of standard grades and sizes. Our engineering knowledge, experience and research are available to assist in the selection of the proper brushes for any type of application. If you have not received copies of "Modern Pyramids"—an informative booklet on brush operation and care—write National Carbon Company, Inc., 30 East 42nd Street, New York 17, N. Y., Dept. 20K.

The word "National" is a registered trade-mark of National Carbon Company, Inc.

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation

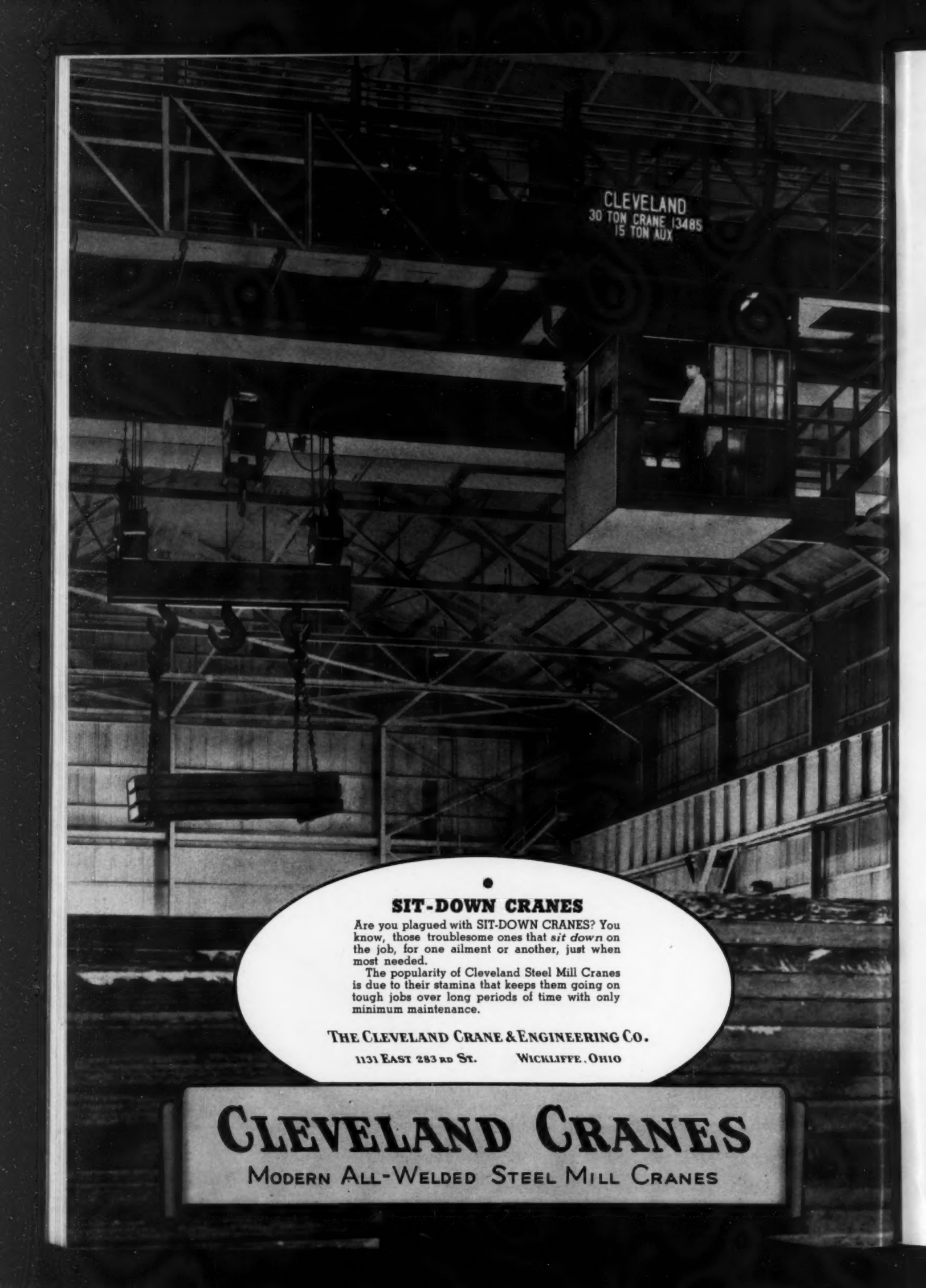
UCC

General Offices: 30 East 42nd Street, New York 17, N. Y.

Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

KEEP YOUR EYE ON THE INFANTRY... THE DOUGHBOY DOES IT!

L
You'll find it on the Rolls in Mills which have a Reputation for Quality plus Tonnage
LEWIS FOUNDRY & MACHINE DIVISION
of BLAW-KNOX Company, Pittsburgh, Pa.
ARMY E NAVY
Also manufacturers of
ROLLING MILL MACHINERY
for the iron, steel and non-ferrous industries
LEWIS ROLLS



SIT-DOWN CRANES

Are you plagued with SIT-DOWN CRANES? You know, those troublesome ones that *sit down* on the job, for one ailment or another, just when most needed.

The popularity of Cleveland Steel Mill Cranes is due to their stamina that keeps them going on tough jobs over long periods of time with only minimum maintenance.

THE CLEVELAND CRANE & ENGINEERING CO.

1131 EAST 283 RD ST. WICKLIFFE, OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops *and* Shorts

NOW that the election is over, name-calling will again revert from the air lanes to a private practice — and believe us, the real experts at it never got on the air.

▲

STEEL, which is usually thought of as "big business," takes a back seat when compared with the United States Army. The latter holds 15,938 square miles of land, with 1⅓ billion sq ft of building floor space; has installed 21,500 miles of electric distribution lines, 2500 miles of gas line, 1120 miles of steam lines, 11,450 miles of water mains, 7910 miles of sewer mains, 3125 miles of storm sewers, and 3600 miles of railroad track; operates 460 hotels, 1200 theaters, 6300 branch stores and 156 laundries.

▲

ACCORDING to the Wall Street Journal, a lot of fellows who complain about their boss being dumb would be out of a job if the boss were smarter.

▲

COMPANIES who have adopted the "don't-you-know-there's-a-war-on?" attitude or who have not kept up contacts with their markets seem to forget that good will is one asset that competition cannot undersell or diminish.

▲

ONE'S reputation for having brains will rarely be questioned if he can only restrain his tongue trying to prove it.

▲

ADJOINING picture captions in the Chicago Tribune: "First of 18,000 MESA workers going on strike in Detroit." "Flag-draped coffins of Yanks waiting burial in United States cemetery in England."

▲

EXPENDITURES for rockets and jet propulsion engines now actually total hundreds of millions of dollars per month. Remember when such things were confined to the pages of the "pseudo-scientific" magazines?

HERE'S to liquor! It works upon the mind.
It makes both men and women talk when they're really not inclined.
It works without a pencil and it works without a rule,
And it makes you think you're smart as hell when you're just a gol darn fool..
— "A Toast to Liquor," from Kreolite News.

▲

ACCORDING to the American Iron and Steel Institute, $1,630,000,000 of government funds and $1,151,000,000 of private funds have been spent in increasing our annual steel making capacity by 12,500,000 tons in the past 4½ years. Present capacity of 94,054,550 tons of ingots and 68,446,310 tons of pig iron per year represents an increase of more than 15 per cent during that period. Industry's expenditures began in 1940, with principal government expenditures starting somewhat over a year later.

▲

IF a man permits his wife to choose his suits, does that give her the right also to pick his pockets?

▲

THE Solid Fuels Administration estimates that there will be a 16,000,000 ton shortage of high grade bituminous coal and 6,000,000 tons of anthracite for the year ending March 31, 1945, even though current production is high. Manpower shortage is responsible for much of this. There are less men mining coal at present than any at time for over 40 years.

▲

TO help industry bridge immediate dislocations after V-E day, the New York Journal of Commerce has published a postwar study, "Transition Opportunities," summarizing 200 outstanding postwar trade potentialities. Attention is called to long pent-up sales opportunities and supply problems in foreign and domestic markets with particular emphasis on foreign possibilities, country by country and product by product.

▲

CORNELL University has broken the ice with an announcement that they will require five years instead of the conventional four for a bachelor degree in all branches of engineering after the war.

▲

METALS of all kinds — steel, copper, brass, bronze, zinc, aluminum, etc., — may take on all the colors of the rainbow in our postwar products. Simple processes of chemical immersion can provide a wide range of colors in irridescent and matte effects, and many of the coloring baths also increase the corrosion resistance of the metal being treated.

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For shock loading or where very heavy loads must be handled on Roller Conveyer, Mathews Spring-Mounted construction should be considered. Spring-Mounted Roller Conveyer is made in three styles, and is establishing service records in heavy industries all over the United States and Canada. Your Mathews Field Engineer can explain how it works and why the Mathews design is superior to other available types of Spring-Mounted Roller Conveyer. He can tell you how its application has minimized the costly maintenance which is usually necessary on Roller Conveyer used under very severe conditions. You will readily understand how the principle of pre-compression protects the bearings and axles of the rollers, yet, at the same time, prevents any bouncing action from taking place. Descriptive literature is available on request.

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Iron AND Steel ENGINEER

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★Within the past few years several Lectromelts, with a range of capacities from 500 lb. to 10 tons per heat, have been installed for billet-size ingot work. This simplified method affords greater tonnages in the steel industry's increasing use of direct arc type furnaces for the production of plain carbon steels for rolling into merchant and reinforcing bars, sheets and other similar products.

In most instances, billet-size ingots are poured so that they can be rolled with one heating. Some of these ingots are as small as 2-inch square by 4 feet long.

Billet-size ingots for rolling into bar stock are ordinarily top cast with a slight taper so as to facilitate ready stripping. Just before the tops solidify, a staple is inserted in the small ingot, and the stripping is usually done by a bar suspended on a hook of a crane, so as to pull out four to six ingots from their moulds at a time.

The billet-size ingots solidify rapidly with practically no pipe. These ingots are noted for their uniformity and fine grain structure. Coarse structure, which frequently characterizes large ingots, is avoided by the rapidity of solidification.

It is customary to quickly transfer the plain carbon billet-size ingot to a continuous type heating furnace for bringing the ingot up to uniform rolling temperature so that it may be rolled direct with one heating. Any required cropping is done after the rolling. In the plain carbon billet-size ingot process, it is customary to obtain highest yields of merchantable bars. The end crops can be returned to the furnace for remelting.

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THREE-ZONED *Temperature Control* ON A *Continuous Furnace*

. . . . automatic temperature control applied to all three zones of a continuous heating furnace has given more production, better quality and higher efficiency . . . .

by B. M. PUTICH, FUEL ENGINEER

A. M. BYERS COMPANY

AMBRIDGE, PENNSYLVANIA

▲ THE chief reason or justification for any automatic temperature control system applied to a heating furnace is that heating results are better than can be achieved by manual operation. In this paper an attempt will be made to explain how an automatic temperature control system, applied to a well designed continuous furnace, is aiding us in getting better heating results than would be possible by manual control.

By better heating results we mean decreased fuel consumption, increased production, and less material loss caused by improper heating which results in surface defect rejects and excessive scale losses. An automatic temperature control system in itself will not guarantee good heating results. We recognize the fact that it takes a combination of a good furnace, good burners, and good control equipment to make possible efficient heating. When all three of these conditions are fulfilled, good heating can be a continued actuality and not merely an off and on occurrence. We learned by experience while heating ingots in soaking pits that all three conditions had to be right in order to obtain good results. At the beginning of our soaking pit operation, only two of the three conditions were correct. We therefore believe that it will be necessary to tell you a little about our soaking pit experience, because it was the result of this experience that dictated the selection of the burner and control equipment for the continuous furnace under discussion.

From 1864 until very recently, the A. M. Byers Company manufactured only wrought iron. The manufacture of steel at the Byers plant is comparatively new, for it was not until World War II had begun that the company put into operation the first of its electric arc furnaces. This was part of an expansion program that was established in order to assist in the war effort and to take advantage of an unusual opportunity to use plant capacity that was available between peak periods of wrought iron production.

Several months prior to the installation of the melting furnaces, the soaking pits were completed and put in operation, and before the completion of the melting furnaces, the soaking pits were used for heating in the conversion of soft steel ingots into slabs and billets for outside steel producers. Since the heating of steel at the Byers plant was an entirely new operation and the heaters assigned to the jobs were experienced only in heating wrought iron, the opportunity to start the pits on low carbon steel served as a stepping stone between wrought iron and high grade alloy steels. We had our difficulties at the start, but as soon as we had collected sufficient data which enabled us to establish definite automatic temperature controlled heating cycles, the heating results improved. With soft steel we learned how to operate the pits on a real production basis by automatic temperature control. However, the blooming

Presented before A. I. S. E. Annual Rolling Mill Conference, Pittsburgh, Pa., May 8, 1944

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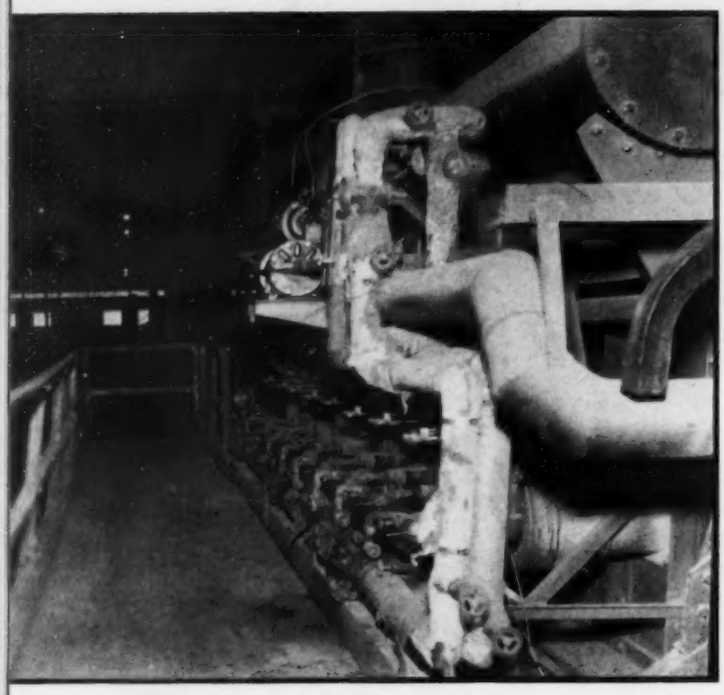


Figure 1 — General arrangement of burners and piping on soaking zone. A similar arrangement is used on the two other zones of the furnace. ↑

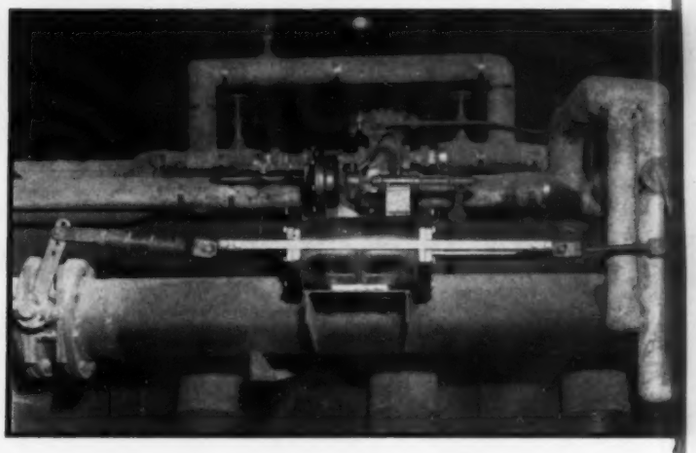


Figure 2 — A small diaphragm assembly and an oil-operated piston regulate the settings of fuel valves according to the outlet air pressure from a pneumatic temperature controller. →

mill rollers repeatedly had to contend with a "hot side" ingot. There was nothing the heater could do to remedy this condition. From all indications, and this is the point we want to make clear, at least one of the three conditions — furnace, burners, or the control system — was not correct. This one defect in heating was apparently not the result of improper furnace design nor of the inadequacy of the control system, but it was almost entirely the result of improper burner design. The burners which were furnished with the original installation were of a high velocity short flame type. With this type of burner we found it impossible to heat ingots at a fast rate without overheating and washing the side of the ingot next to the burner. The burners, therefore, were replaced by a low velocity long flame type which almost entirely eliminated the hot side ingot. Therefore, we learned by actual experience that to do a good heating job, it takes a good combination of the three factors — furnace, burners, and controls.

With this change in burners and some minor modifications to the control system, we have been heating with satisfactory results, by automatic temperature control, not only soft steel ingots but also all of the alloy steels produced by the electric furnaces and the alloy steels made in our acid bottom open hearth furnaces. The greater bulk of the soaking pit tonnage has been alloy steel, ranging in nickel content from 1 to 3 per cent. However, we have also made and heated stainless steels, ball bearing steels, die block steels, high carbon tool steels, etc. In changing from one grade to the next, it has only been necessary to change the temperature control point and limit the top firing rate depending on the thermal conductivity of the steel being heated. The pits are normally fired with natural gas; during periods of natural gas curtailment, they are fired with No. 6 fuel oil.

Since furnace design, burner equipment, and control equipment are interdependent for good heating results, a brief description of each of these items will be helpful before proceeding with the discussion of furnace performance. In the following description of the furnace, we have purposely confined our remarks only to those features of design and only those dimensions which have a direct bearing on heating results.

The furnace we selected is the conventional triple-fired, end-charged end-discharged type with all three zones firing in the same direction — that is towards a downtake at the charging end of the furnace. The effective hearth length is approximately 62 feet, and the inside width is 17 feet 6 inches, face to face of brick. This makes it possible to heat sections up to 16 feet long and the manufacturer's rated capacity of 50 tons per hour is based on heating slabs or billets of this length from cold to rolling temperature. This is equivalent to a heating rate of 100 pounds per hour per square foot. The soaking hearth is 12 feet long.

The furnace is normally operated on an intermittent basis; consequently, it is not equipped with a recuperator, although provision has been made for its installation if conditions change in the future.

BURNER EQUIPMENT

Each zone of the furnace is equipped with eight long flame combination natural gas and fuel oil burners. The maximum firing capacity of the 24 burners is 125,000 cubic feet of natural gas per hour, or the equivalent Btu in No. 6 fuel oil. The firing capacity of the soaking zone is 20 per cent of the maximum capacity, and the balance is equally divided by the top and bottom banks of burners in the primary heating chamber.

Each burner is equipped with a blast gate in the air line and a gas cock in the gas line, which are used for shut-off purposes only. The pipe headers are ample in size, and the piping layout is such that good heat distribution is accomplished with the individual burner blast gates and gas cocks in a wide open position. After the temperature relationships among the three zones

were established, we have never found it necessary to manually throttle any individual burner. Increasing or decreasing the firing rate of an entire bank of burners by automatic temperature control has been giving us uniform heating regardless of the rate of heating or of the section being heated.

The oil burners are of a steam atomizing type, the atomization taking place at the tip of the burner. Each burner is equipped with an oil regulating valve and a steam globe valve. Here again we operate with the individual burner valves in a wide open position. However, oil burners require a great deal more attention than gas burners. Therefore, when the furnace is down, we usually remove, inspect, and thoroughly clean all the oil burners.

Some of the advantages of complete automatic control are lost if it is impossible to operate with all individual burner valves wide open — that is, we then depend on the heater's judgment to get good heat distribution. This condition would be satisfactory if all the heaters would agree to one particular setting, which is usually not the case. Our burners for this reason are operated in a wide open position day and night. Of course, if the burners are fundamentally wrong, or inaccurately machined, or the piping system not sufficient, it would be impossible to operate in this manner and still get good heat distribution. Generally speaking, it has been our experience that unequal distribution in a bank of burners is not because the burners are not right or identical enough, but because there is something wrong with the piping or the valves ahead of the burners.

Air for combustion is supplied by a fan having a capacity of 22,000 cfm at 8 inches water column. Figure 1 shows the general arrangement of the burner equipment and the piping layout. This leads to a discussion of the automatic temperature control system as applied to the furnace and burner equipment.

AUTOMATIC TEMPERATURE CONTROL SYSTEM

Throughout the discussion of the control system, we will not take time to describe in detail the parts of our system which are common to most furnaces. We will confine our discussion to those features which we think are a departure from the conventional way of controlling a three-zone furnace.

All three zones are equipped with individual temperature controls which are identical. The temperature controllers incorporate an electrical circuit for temperature measurement and a pneumatic system for its control. The temperature measuring element is a closed-end radiation tube, and the measuring circuit employs the potentiometer principle. Each temperature control system operates in the following manner: When the temperature moves away from the control point, it creates an unbalance in the electrical measuring circuit, and by means of a mechanism which moves a slidewire, balance is again restored almost immediately. A cam moves as a unit with the slidewire and actuates the stem of a pilot valve, which produces a new outlet air pressure. This new air pressure repositions an oil operated piston which regulates a gas butterfly valve or a combination oil and steam valve. For every temperature within the preset throttling range, the stem of the pilot valve has a different position and thereby produces a different outlet air pressure ranging from zero for minimum fuel flow to 15 pounds per square inch for maximum flow. The oil operated piston, which regulates the final fuel valve, has a definite position for every air pressure sent out by the temperature controller pilot valve. This is accomplished by the arrangement shown in Figure 2. The air pressure from the temperature controller is applied to one side of a small diaphragm assembly mounted on the cylinder of the oil operated piston. This diaphragm assembly actuates a pilot valve which admits hydraulic oil to one end and exhausts it from the other end of the cylinder. A spring in compression opposes the force of the air pressure on the diaphragm. This spring seats in a movable socket, the position of which varies with the movement of the piston by means of a cam arrangement. For example, with an increase in air pressure we get an increase in spring compression which thereby restores the diaphragm to its neutral position, bringing the piston to a stop. As a result, the position of the piston, which regulates the final control valve, corresponds to actual temperature. Similar results can be accomplished by a diaphragm motor, but we preferred the advantages of a piston with a 10-inch stroke. The piston can be

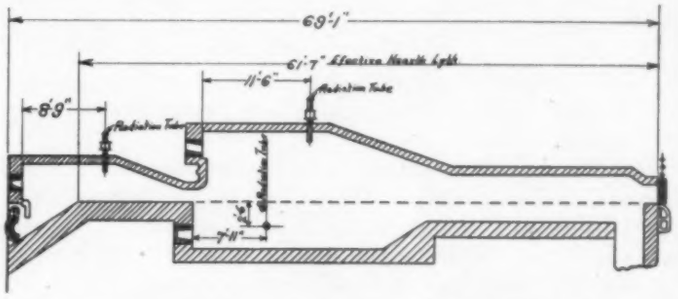


Figure 3 — Sketch showing arrangement of furnace and location of radiation tubes for temperature control.

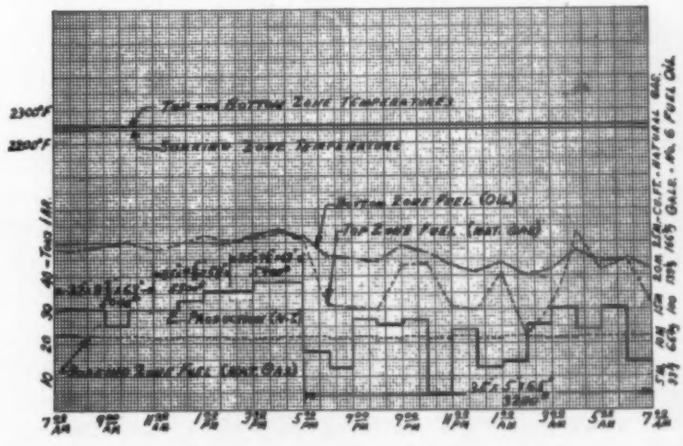

Top and Bottom Zone Temperatures
Soaking Zone Temperature
Bottom Zone Fuel (Oil)
Top Zone Fuel (Nat. Gas)
Soaking Zone Fuel (Nat. Gas)

Figure 4 — Chart showing rates of fuel input to each of the three firing zones, together with tonnage heated.

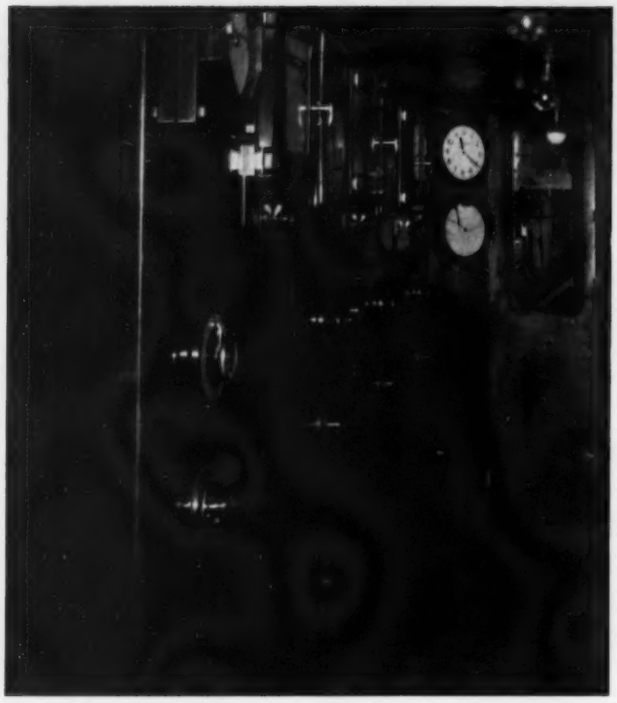


Figure 5 — All instruments and controls for the furnace are mounted on a central panel board.

Figure 6 — Rear of the panel board shown in Figure 5.

operated with compressed air but oil as the pressure medium gives slower movement with less hunting action.

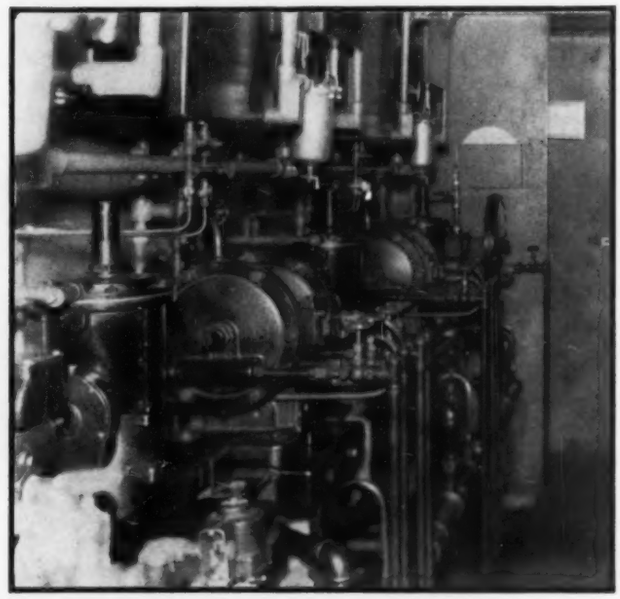
We chose the pneumatic type of temperature control mainly because of its simplicity compared to an electrically operated control. The average instrument man can grasp the principle of a pneumatic control more quickly than he can that of an electrical control. In addition, air operated controls usually have several pressure gauges which indicate its operation and which help to locate the point of trouble when the control is not operating properly. We have confidence in air operated controls mainly because we understand their principle. We are not as confident about an electrically operated control, especially when it has to rectify from a-c to d-c to make the final control valve move.

Figure 3 shows the location of the radiation tubes in the three zones. In the soaking zone the tube is located in the center of the roof close to the discharge knuckle. In this zone furnace temperature and steel temperature are almost identical; therefore the controlled temperature is approximately the same as the slab being discharged from the furnace. In the top zone the tube is also located in the center of the roof laterally, but close to the point where the preheated steel enters the high-heat zone, thereby controlling the rate of firing so that the steel will be ready for soak when it enters the soaking zone. The location of the radiation tube in the bottom zone is about 2 ft., 6 in. below the skids and further along in the hot zone than the one in the roof. The temperature control of the bottom zone is particularly important when heating nickel or other alloy steels. Contrary to general belief and practice, the temperature control of the soaking zone is far less important than the temperature control of the main heating zone.

This is clearly shown graphically by Figure 4, which shows that the fuel consumption in the soaking zone is practically constant despite the variation of slab sizes and hourly production rates. The firing rates in the two zones of the main heating chamber vary with the slab sizes and tons per hour.

Each zone is equipped with a fuel-air ratio regulator which proportions the flow of air to the flow of gas or oil at all rates of firing. These regulators are oil operated. The fuel oil flow is measured by means of a positive displacement meter, and the oil flow is translated, by means of a mechanism, into a proportionate air pressure suitable for actuating the ratio regulator when firing with oil.

Each zone is also equipped with an integrating two-pen recording flow meter in order to record and integrate the fuel flow and to record the air flow. These meters are a great help in establishing heating practices on the various grades of steel. A study of the meter charts in conjunction with the temperature charts helps

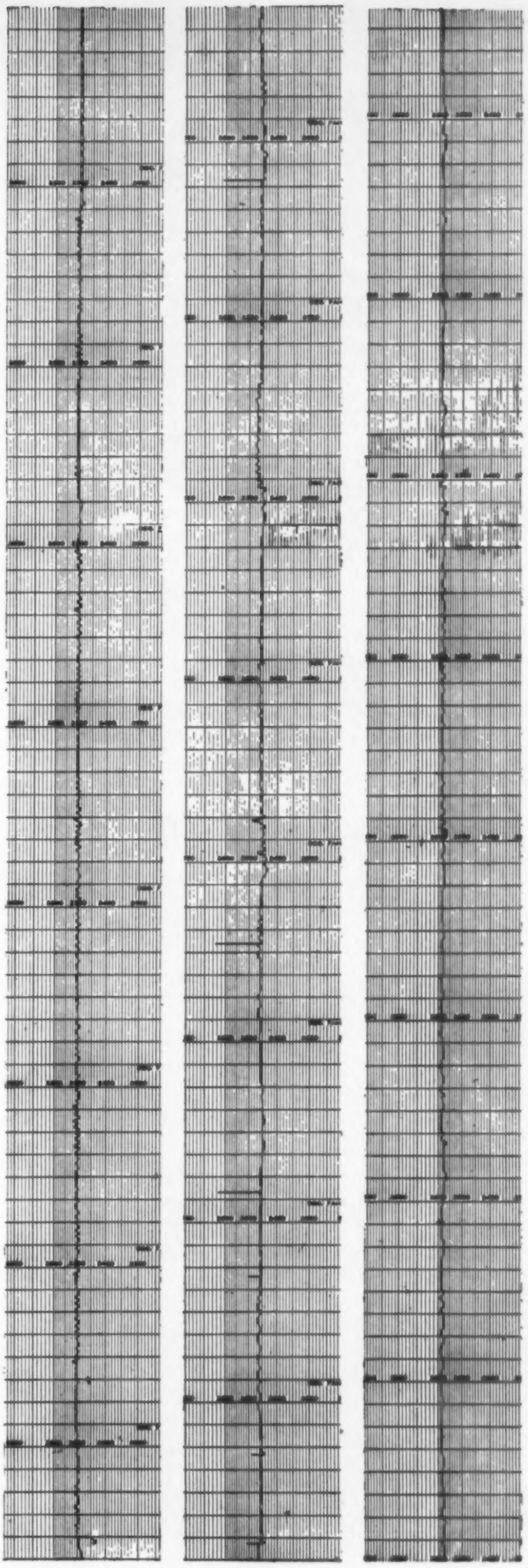


to explain why we are getting good or bad heating results. With the aid of these charts we have been able to explain the difficulties that often occur on night turn. They also serve as a good check on the operation of the ratio regulators, which is particularly helpful when firing with fuel oil. In addition, the daily gas cost of a furnace such as the one under discussion may be as high as $800 a day; consequently, meters that tell a complete and accurate story are a real necessity. We do not believe in using indicating flow meters or non-integrating recorders which are the types usually recommended by the furnace manufacturer.

Furnace pressure is maintained constant by a furnace pressure regulator. The furnace pressure is measured in the roof of the soaking zone and is recorded on a furnace pressure recorder. The regulator is oil operated.

All of the above instruments and their adjusting dials are mounted on a control panel board as shown in Figure 5. The panel board is enclosed front and back, and ample space was allowed back of the board for the in-

Figure 7 — Temperature record from each zone; soaking zone to the left, top zone at center, and bottom zone at right. →



stallation of the controls including the positive displacement oil meters. This is shown in Figure 6.

It might be of interest to mention that the furnace and the controls were erected and put into operation by our own organization without any outside supervision. This gave us the education necessary to cope with the furnace and control problems which usually arise after a furnace is put into operation.

FURNACE PERFORMANCE

In most steel plants a continuous furnace is installed with the purpose of doing one particular heating job, such as heating slabs for a plate mill, billets for a structural mill, slabs for a strip mill, etc. Usually the steels heated in such furnaces are substantially the same day in and day out. In such cases a temperature control system similar to the one just discussed may not be entirely necessary. In our particular case we are heating materials in our continuous furnace for two finishing mills. One of these is a plate mill on which we roll universal plate up to 46 in. wide and sheared plate up to 84 in. wide. The other mill is a bar mill on which we roll skelp and bars up to 15¼ in. wide and rounds up to 4½ in. in diameter. Our furnace, mill, and table layout is such that we can heat materials in the furnace for either of the two mills at one time or for both mills at the same time. The materials we are heating are not the same from day to day.

The chief reason for the installation of the continuous furnace was to enable us to finish, beyond the slab and billet stage, the various grades of alloy steels that we are manufacturing. It was realized that we would have to heat materials of such quality that the furnace might have to operate at a rate as low as 15 or 20 tons per hour, particularly if rolling light gauges on the plate mill, and up to 50 tons per hour and more if rolling suitable section rounds on the bar mill. For a short time, prior to the installation of the continuous furnace, nickel alloy steels were heated in side-door batch-type plate mill furnaces. It was very difficult, with one-side heating, to obtain precise control of scale formation and to prevent it from forming too heavily on the top of the slab. Nickel alloy steels are noted for developing a tight scale which is difficult to remove in the initial passes of the rolling operation, resulting in bad surface. In addition to tight scale, nickel steels, if improperly heated, are susceptible to a phenomenon which metallurgists call nickel concentration. This in effect is the selective oxidation of iron at the surface of the slab developing a concentration of nickel, the concentration being a function of the top surface temperature. With improperly heated slabs, in addition to bad surface it is not uncommon to find near the surface of the slab isolated zones where the nickel content had multiplied by several times. To hold scale and nickel concentration to a minimum, all slabs were covered with a layer of slack coal and a scrap plate. In spite of this protective cover-

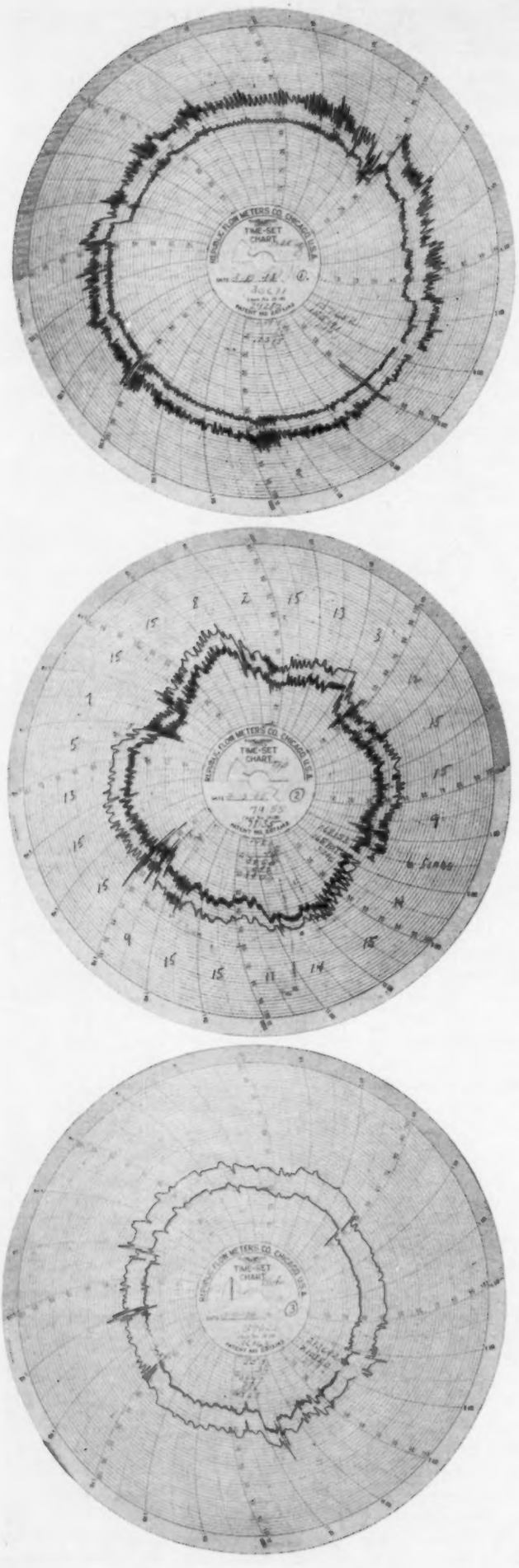


Figure 8 — Charts showing fuel and air flow to each zone; soaking zone at top, top zone at center, and bottom zone at bottom.

ing, the rejects on account of bad surface were high. For this reason the control of slab surface temperatures, both top and bottom, is very important when heating nickel alloyed steels in a three-zone furnace.

Figure 7 shows the temperature charts of the three zones when heating nickel alloy slabs. The soaking zone (left) is controlled at 2300 F, the top (center) at 2350 F, and the bottom (right) at 2220 F. We control the bottom zone at a comparatively low furnace temperature in order to hold the scale formation on the bottom of the slab to a minimum. We had to establish this practice when the furnace was first put into operation because at that time and until very recently our mills were not equipped with a high pressure hydraulic descaling system. Until the hydraulic system was installed, we used medium pressure steam and salt for descaling purposes. Since salt could not be applied to the bottom of the slab and since we had to rely on steam only, we had to resort to this low bottom zone furnace temperature. We still follow this practice whenever the furnace is not operating at a high tonnage rate in order to prevent scale build-up on the soaking hearth.

We purposely selected the charts shown in Figure 7, because they represent an unusual furnace operation by automatic temperature control. On this particular day, in addition to heating slabs in the continuous furnace for the plate mill, we were also heating slabs in four other batch-type furnaces for the same mill. The slabs from these four non-temperature controlled furnaces were rolled as soon as ready, and during such time the continuous furnace lay idle. In this way the entire available rolling time was completely utilized, because the slabs from the continuous furnace were always ready for rolling throughout the 24 hour period, Figure 8 shows the fuel flow and air flow to the three zones which maintained the zone temperatures constant during this period, even though the production from the furnace varied from two to fifteen slabs per hour. The slabs heated were a double row of 32 in. x 6⅜ in. x 63 in. weighing 3600 pounds, and they were rolled into ½ in. plates. The average hourly production from the continuous furnace over this 24 hour period was 20.5 tons at 2,300,000 Btu per ton. With this section we normally average 30 tons per hour. Due to the length of the finished plates and the rigid inspection requirement, the furnace production is limited because of the insufficient capacity of the hot bed.

We have analyzed an 8-hour turn on 1½ in. nickel alloy steel plates. These are rolled from 35 in. x 12 in. x 63 in. slabs weighing 7500 pounds. When we first started to heat this section, we averaged six per hour. We later increased it to eight. Now we average ten slabs per hour or 37½ tons, which is equivalent to a heating rate of 116 pounds per square foot. The furnace time for this 12 in. slab is 4 hr, 13 min. Compared to a 16 ft long section, which is the maximum that could be charged, 65 per cent of the hearth in this case was covered. The fuel consumption during this run was 1,950,000 Btu per ton. During a recent operation we heated and

rolled 1339 slabs of 1 to 3 per cent nickel alloy steel plates. The inspector's report showed that the primes were 99.4 per cent and only one plate, or less than .1 per cent, was rejected on account of surface, whereas from the in-and-out type furnaces the rejects were approximately 10 per cent in spite of the protective covering mentioned previously. The next time we heat this section, we anticipate rolling 12 pieces per hour, equivalent to 45 tons or 139 pounds per square foot.

In addition to alloy steel, we preheat to 2100 F wrought iron in our continuous furnace. This is necessary due to increased demands for wrought iron products and due to the deficient capacity of existing high temperature furnaces. After preheating, it is transferred to the high temperature furnaces, where the heating to rolling temperature is completed. The rolling temperature of wrought iron is above 2500 F. Wrought iron is a two component metal consisting of high purity iron as the base metal and iron silicate as the other component. It is impossible to preheat wrought iron in a pusher-type furnace beyond 2100 F because of the danger of sticking since iron silicate fuses at about 2150 F. On account of unavoidable mill delays, we do not believe that it would be possible to preheat without automatic temperature control within such proximity of the fusion point without encountering a great deal of furnace trouble. The increase in tonnage resulting from this practice has been substantial and helped considerably in fulfilling War Production Board directives. The high furnace temperature heating time was reduced to practically one-half with no difference in the quality of the product.

We have recently heated a chrome-molybdenum steel, which to date has given us our best tonnage record. The slab sections charged were a double row of 29 in. x 7½ in. x 89½ in. weighing 5500 pounds. They were rolled into ⅞ in. universal plates. We had no difficulty in heating 22 pieces or 60.5 tons per hour. This gives a heating rate of 142 pounds per square foot. The furnace time for this slab was 2 hr, 18 min, or 18½ minutes per inch of slab thickness. The top zone was controlled at 2390 F, the bottom at 2360 F, and the soaking zone at 2310 F. The firing rate was 70 per cent of the maximum, and the fuel consumption was 1,600,000 Btu per ton.

In conclusion, we feel that the automatic temperature control system has given us a very flexible and efficient furnace. We are heating various grades of material. In changing from one section to another or from one grade to a different grade, it is only necessary to reset the temperature control points. The slab temperatures and slab uniformity are consistent from hour to hour and day to day. With temperature controls the furnace is never overheated, for in the case of mill delays, the fuel is automatically cut back, maintaining safe furnace temperatures. As a result, the furnace refractories appear to be in practically the same condition today as they were a year ago when the furnace was put into operation. We are satisfied that after a year's operation, we are obtaining more production, better quality, and higher efficiency with automatic temperature control than would be possible by manual operation.

DISCUSSION

PRESENTED BY

LOUIS MOSES, Superintendent of Rail Mill and Roll Department, Bethlehem Steel Company, Sparrows Point, Maryland.

B. M. PUTICH, Fuel Engineer, A. M. Byers Company, Ambridge, Pennsylvania.

J. F. BLACK, Assistant Works Manager, Atlas Steels Limited, Welland, Ontario, Canada.

W. T. CASE, Plant Engineer, A. M. Byers Company, Ambridge, Pennsylvania.

H. L. HALSTEAD, Assistant Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland.

B. B. BARGMAN, Superintendent of Fuel, Carnegie-Illinois Steel Corporation, Munhall, Pa.

W. BRUTSCHER, Metallurgist, Republic Steel Corporation, Massillon, Ohio.

H. W. SHAFFER, Power and Fuel Engineer, Carnegie-Illinois Steel Corporation, Youngstown, Ohio.

M. J. BRADLEY, Engineer, Leeds and Northrup Company, Philadelphia, Pennsylvania.

Louis Moses: Mr. Putich, you have discussed the heating of a wide range of grades of material — from preheating wrought iron to heating alloy steels. Do you consider this furnace with its control system as being distinctive from the continuous furnaces found in most steel plants?

B. M. Putich: Most continuous furnaces usually heat only one class of material. In our furnace we heat many grades of material of varying sizes and thicknesses. Also, we know that no other plant preheats wrought iron in a pusher-type furnace. The automatic temperature control of all three zones is also unusual because generally only the soaking zone temperature is controlled. In our particular case, the control of all three zones is not only helpful but essential. For these reasons, we believe our continuous furnace is different from the conventional continuous furnaces found in most steel plants.

J. F. Black: The wide range of heating from wrought iron to high grade alloy steels, which is performed by the furnace described by Mr. Putich, is very unusual and it proves that a tonnage furnace can also be a very flexible unit.

I am particularly interested in Mr. Putich's experience in heating high grade nickel steels and would appreciate additional comments on the control of finished surface of such steels. I understood that he had been troubled by spotty scale conditions, which affected billet surface on the nickel grades. His figure of less than .1 per cent rejections on account of surface faults due to rolled in scale is good and indicates that he has made progress in solving this problem.

I am also interested in the combination or dual control for two fuels. I would like to ask how quickly the change-over is made. On a continuous furnace this could be very important.

I like the idea of their installing control equipment without outside supervision. I got the impression that their organization also designed the controls as well as installed them.

W. T. Case: It should be understood, and it is evident from the illustrations, that none of this equipment is "home-made." The entire erection of the furnace and the installation of control equipment were performed by A. M. Byers Company's own organization. This experience enabled our men to become thoroughly familiar with details of equipment, and the knowledge and experience thus gained in erection were of great value in subsequent operation and maintenance.

J. F. Black: It is certainly beneficial to have men within an organization who have a thorough understanding of control systems and who are interested in knowing what makes them function. There is no better way of insuring good operation.

B. M. Putich: I would like to thank Mr. Case for correcting the erroneous impression that some may have received concerning our control system. The point that I want to make clear is that the control system on our furnace consists of a combination of controls made by several manufacturers and is not a conventional type as usually recommended by the furnace manufacturer.

Referring to Mr. Black's comments on surface defects on nickel steels, I would like to point out the conditions that make good surface possible. We cited the operation in which we lost one slab out of 1339. More recently we heated and rolled 579 nickel grade slabs without losing any. The small percentage of rejects can be attributed primarily to the fact that each zone is temperature controlled. When nickel steel slabs are overheated, the percentage of surface defect rejects increases. Temperature controls help to prevent overheating.

Furnace atmosphere is also very important. We maintain practically a neutral atmosphere. The last flue gas analysis, when firing with fuel oil, showed 15.4 per cent CO_2 and a trace of oxygen. The sample was taken in the last door of the furnace. We have been operating on fuel oil since last November, and the ratio regulators on fuel oil in the top and bottom zones are set for a 5 per cent deficiency of air. The soaking zone is set for a deficiency of 10 per cent to allow for the infiltration of air that enters in at the discharge door.

Mr. Black raised the question in regard to changing the firing from gas to oil or vice-versa. This is accomplished in a few minutes for each zone.

H. L. Halstead: Why is the radiation tube which is used for controlling the furnace fuel sighted through a closed-end tube instead of an open-end tube?

B. M. Putich: We cannot use an open-end tube because we are heating different grades of steel, each of which has its own emmisivity factor. With an open-end tube we would have to change the temperature measuring circuit each time we changed to a different grade of steel. In our case, with frequent changes in grades of steel, this would be impractical.

B. B. Bargman: I would like to know whether consideration was given to emulsion mix burners instead of the tip atomizing burners used on oil firing. In addition, when heating high nickel steels, do you find any difference in scale results or quality with respect to firing with gas as against oil?

B. M. Putich: We use the tip atomizing type on our continuous furnace and the emulsion-type on our soaking pits. The tip atomizing type gives a softer and a more luminous flame, both of which are desirable and practically essential to the proper operation of a continuous furnace. To a certain small degree these desirable features are sacrificed when firing with emulsion-type burners. However, emulsion-type burners give less trouble, as they are much easier to keep clean and perform very satisfactorily on a batch-type furnace such as a soaking pit.

In regard to the second question, we can say that our records indicate that, in general, we had less surface defect rejects due to scale when firing with fuel oil than when firing with gas. Our furnace has been in operation about a year. The first six months it operated on natural gas and the last six months, due to natural gas curtailment, it has been fired with fuel oil. We therefore had six months of experience before we had to convert to fuel oil. We knew more about the furnace, more about the controls, and more about the different grades of steel. For these reasons, the results have been better when firing with fuel oil. When we go back on gas, we feel that we will equal the results attained with oil.

B. B. Bargman: What happens when the furnace is operating at a continued high rate and suddenly the furnace, due to a mill delay or other reasons, has to be slowed down? How do the controls operate under such conditions?

B. M. Putich: When the furnace is operating at a high tonnage rate, the controlled temperatures in the high heat zone are set at a high point. The rate of firing varies with the mill demand, regardless of whether the furnace is operating at a high tonnage or low tonnage rate. Therefore, the moment a mill delay occurs, the controllers automatically start cutting back the rate of firing in order to maintain the temperatures at which the zones are set. If it happens to be a long delay, the controlled temperatures in the back zone have to be lowered, otherwise the steel in that zone would overheat. On the average the automatic temperature controllers take care of 90-95 per cent of normal mill delays.

B. B. Bargman: While you have indicated certain variations in production rates, do you have any variation in slab sizes coming through your furnace, particularly in thickness? For example, do you have 4 in. or 6 in. thick slabs followed by 10 in. slabs?

B. M. Putich: We have heated sections ranging from 2½ in. to 12 in. in thickness. Each time we light the furnace we usually start with a soft steel slab 2½-4 in. thick. We then may start to push wrought iron, which is 4-5 in. thick, and this may be followed up with nickel steel ranging in thickness from 6 in. to 12 in. While the material is traveling through the furnace, the heaters know when and where to change the temperature control points to take care of the changing charging conditions.

W. Brutscher: I would like to ask Mr. Putich if he has had any experience in the heating of stainless steel, straight chrome types, and chrome-nickel types. I am principally interested in surface preparation of billets, slabs, and final end product as far as surface is concerned.

B. M. Putich: We have heated these types of steels in our soaking pits, but we have not as yet heated any

of these grades in the furnace under discussion. I am therefore unable to answer your question with respect to the final end product as far as surface is concerned on these particular steels.

H. Shaffer: I would like to ask if anyone has had any experience with the breaking of sighting tubes. We have been using an open-end sighting tube located within 4 in. of the steel. It is provided with a stream of compressed air to prevent the entrance of dust, smoke, or flame. The life of the tubes is about three to five weeks. Has anyone had experience with longer tube life?

B. M. Putich: Mr. Shaffer pointed out one disadvantage of an open-end tube which is difficult to overcome. In our soaking pits we measure and record actual steel temperature with a closed-end tube. The distance that the target tube projects through the furnace wall or roof influences the temperature reading. This distance is determined by checking the steel temperature with an optical pyrometer when the steel is near the end of the soaking period, and then moving the tube in or out until the recorded temperature coincides with the optical reading. After each furnace-rebuild or target tube renewal, this procedure or check is repeated. The distance that the tube projects through the wall varies with each furnace. One-half of an inch makes a considerable difference in the temperature reading. This method of setting target tubes makes it possible to control all of our soaking pits at identical temperatures.

The average life of the target tubes in our soaking pits is about one year, and the failure is usually caused by the sagging of the furnace wall.

We have had no experience with open-end tubes on the continuous furnace. The original closed-end tubes are still in service. We have had no difficulty in properly controlling slab and billet temperatures with closed-end tubes.

M. J. Bradley: I would like to offer a few comments on Mr. Putich's excellent paper and on the discussion that followed. I feel sure that all are convinced that he has engineered an efficient reheating furnace and control system. The large degree of turn-down provided by the control equipment is unusual. It seems to be doing an efficient job. Frankly, however, I am not convinced by the reasons mentioned that the pneumatic type of temperature control equipment is simpler or better adapted for steel plant usage than the electrical type.

Mr. Putich has explained how different temperature responses are obtained by extending the hot end of the sighting tube into the furnace varying distances. The optimum response for each location can be determined only by the cut and try method under average operating conditions. Thus, if the sighting tube is removed for inspection or a new one installed, it is important that it extend into the furnace exactly the same distance as the previous one if the same temperature effect is to be measured. It would appear that this method of extending the sighting tubes within the soaking pit increases the possibility of breakage and maintenance.

On soaking pit installations, the method used generally is to have the hot end of the sighting tube placed about one-inch back from the inside surface of the pit wall. Thus, it is protected from being hit by the ingots. In order to insure efficient temperature response by circulation of the hot gases, the pit wall is cupped out about 12 in. in diameter and 6 in. deep around the sighting tube. This method exposes the sighting tube a distance approximately equivalent to 2½ diameters of the tube. It insures the same relative temperature response, can be duplicated easily, and gives ample protection of the sighting tube from mechanical breakage.

The sighting tube referred to by Mr. Shaffer is very much different from the closed-end sighting tubes being used on the furnace under discussion. I believe he refers to a special open-end type tube which is installed through the furnace roof and extends down 6 or 8 feet to just above the slab surface. It is used in measuring slab or work surface temperatures, and it is made of two or more sections fastened by couplings. It is thick walled and quite heavy. The most frequent cause of failure of such an open-end sighting tube is due to mechanical breakage caused by a pile-up of slabs in the furnace or by the tube being installed directly in front of the burner and subject to direct flame impingement.

B. M. Putich: Mr. Bradley mentions the fact that the projection of the sighting tube within the soaking pit increases the possibility of breakage. This, in our case, is no problem. The design of our pits is such that the target tube can be extended through the wall without exposing it to the danger of being hit with an ingot or ingot tongs.

We have both the electrical and pneumatic types of temperature controls in our plant. From an operating point of view, we prefer the pneumatic type. This type has been giving us excellent results, and we are pleased that we selected it for the furnace under discussion.

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Heating AND Rolling IN THE Bar Mill

. . . . no set prescription may be made for heating and rolling steel, particularly in the bar mill, where so many items contribute to the success or failure of the operation . . . . each mill must be subjected to individual study and must be constantly improved . . . .

▲ THERE have been many headaches in bar mill heating and rolling. A good many of these headaches have been relieved and more of them are being relieved as each day goes by. Probably all of us will admit bar mill operation is a great deal easier today than it was 15 or 20 years ago. There have been vast improvements which make the work easier and simpler. These improvements are going on daily. It has not been an overnight improvement, but rather a steady and gradual improvement, but we still have a long way to go. In the next 10 or 15 years we will see vast improvements and learn more about bar mills than we ever thought there was to learn about them.

Basically, there have been few changes in heating or in rolling. Years ago we charged a billet in a furnace and heated it, and it is the same today. Likewise, in rolling the billet was run through rolls and reduced in size to the required section, and essentially it is the same today. But there have been numerous improvements in methods of applying the basic principles, in methods of operation and handling.

It was not so many years ago that 10,000 to 15,000 tons was considered an excellent monthly production for a bar mill. Today we have bar mills producing 25,000, 30,000, 40,000 and even over 40,000 tons in one month. It is very obvious that in order to accomplish this great increase in production improvements must have been numerous. These improvements have been chiefly in charging and drawing machinery, furnace design and construction, methods and manner of applying fuel, improved rolls and housings, improved electrical equipment, improved guide equipment, improved hot beds and shearing equipment and so on down the line from billet yard to the shipping end.

Today bar mill stock is generally heated in continuous furnaces, some single fired, some double fired, some with recuperators and some without recuperators. Chiefly the fuel is producer gas, byproduct coke oven gas, oil or tar, and in some cases a combination of more than one of these fuels.

The fuel that will give the best results has been the subject of many discussions and arguments for years. Good results have been observed from all these fuels, but in order to obtain good results it is necessary to have the proper equipment and proper burner installation to insure getting everything possible out of the fuel being used. In most cases it is probably advisable to use the fuel most economical from a plant standpoint and install equipment which will give maximum efficiency with this fuel.

In order to obtain good results from a furnace it is highly desirable to have it properly insulated. The bricklayers sometimes are opposed to insulation on a furnace because they think it is severe on the brick work and in some cases this may be true to some extent, but after all the furnace is built with one prime purpose in mind, and that purpose is to heat steel, not to protect brick. Furthermore, if a furnace is insulated and does prove hard on refractories, it is very often possible to improve the construction and quality of brick so that the brick work will stand the "gaff." This has been proved many times. Insulation is a great fuel saver. When there are numerous shut down periods, insulation is a definite advantage as the furnace cools slowly and in this way is easier on the brick work as compared to a furnace which cools quickly. Also, less fuel is required in the lighting-up process.

Presented before A. I. S. E. Annual Rolling Mill Conference, Pittsburgh, Pa., May 8, 1944

by J. L. McHUGH, GENERAL FOREMAN

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PITTSBURGH, PENNSYLVANIA

For many years most furnaces were constructed with the flues to the stack at the extreme charging end of the furnace, but during recent years a definite advantage has been found in having a part of the furnace in the rear of the flue leading to the stack. This construction permits carrying of high temperatures in the front of the furnace and at the same time a charging end of low temperature, highly desirable when charging the harder grades of steel. The charging end temperatures of some furnaces run pretty high and when charging hard grades of steel it is necessary to reduce the flame, dropping the temperature of the entire furnace in order that the temperature at charging end will be suitable for the steel being charged. But if the charging end of the furnace is in the rear of the flue to the stack it gives comparatively low temperature and does not necessitate reducing the temperature in the front of the furnace so often.

Steel should be heated with a gradually rising temperature. The charging end temperature should be as low as it is possible to go (200-300 F if possible) and the billet should be gradually brought to the desired rolling temperature at the drawing end. Increasing and decreasing temperatures of a billet as it passes through the furnace is not desirable. It is especially detrimental to the finish of the bars being rolled, as it very often freezes the scale, makes it difficult to break the scale as it passes through rolls and sprays, and very often results in pitted surface. Also it lends towards sticking the billets in the furnace and this always is a very unpleasant situation.

Many top double fired furnaces are constructed with a heating and soaking zone. In many cases the soaking zone is run at a lower temperature than the heating zone. Under some circumstances this may be an advisable way to heat steel, but for the most part we feel it advisable to have the front or drawing end at the highest temperature. This allows the billets to be heated with a gradually rising temperature to the desired rolling temperature. In other words, the billet reaches its highest temperature at the point of drawing from the furnace. There is very little advantage in bringing the billet to a high temperature at, say, three-quarters of the way through the furnace and then dropping it 100 or 150 degrees to go through the balance of the furnace. This of course is done with the idea of producing uniform temperature, but we feel it is better to obtain the uniformity by proper burner adjustment and by taking more time to bring the billet up to temperature.

Burners, flues, stacks, gas, air lines etc., and the good maintenance of this equipment has a great deal to do with the efficiency of any furnace. At all times they should be in good, clean condition.

In order to obtain maximum results from a furnace, water-cooling should be kept to a minimum. When water-cooling can be avoided it is advisable to do so. Water-cooled doors, door frames and skids are a disadvantage in heating.

Construction of roofs, sidewalls, door arches and bottoms is of great importance because this determines the life of the furnace and the amount of repair work. There cannot be any set formula for this. Every furnace seems to have its own peculiarities and it is necessary to study each particular furnace to find the construction and brick that will stand the "gaff." What works on one furnace sometimes does not work on another due to some different condition. It is very important that your own particular conditions be studied and the furnace constructed and revised if necessary according to conditions which develop.

Different grades of steel always present quite a problem in the continuous furnace. There are grades of steel requiring certain temperatures and other grades which should have a higher or lower temperature. This is very difficult to control in a continuous furnace but a great deal can be done in this respect by studying the order of charging and segregating grades according to desired temperatures.

To roll good bars the billet must be heated properly; it must be heated slowly. Fast heating is all right for some grades of steel but many grades require slow heating. A properly heated billet, provided it has been conditioned properly, should produce a good bar provided the mill setup is correct.

In order to produce large tonnage on a quality basis a mill must at all times be in good mechanical condition. Housings in particular must be solid. Spring of the rolls must be kept to a minimum. In this respect a housing with a solid bottom is superior to a housing with a wedge under the bottom roll. The wedge is more or less of a fictitious convenience to adjust rolls and bring them to proper elevation. In most cases it is desirable to adjust the elevation of the top roll and leave the bottom roll alone. This is particularly true on table mills where it is advisable to line the bottom roll with the tables and leave it there. On table mills it is possible to deliver the bar with practically no pressure on the delivery guides if the bottom roll is lined up properly with the tables. The delivery guides should be large enough to allow the bar to ride through freely; they should do nothing more than strip the front end. When the bar reaches the

first table roll there should be very little (if any) pressure on the guides. This type of delivery is hard to control on some types of mills, especially repeater mills, but it can be controlled on repeater mills by the use of twister rolls set at proper elevation. Twister rolls offer a big advantage in twisting the bar over the ordinary twist guides. They are a great help in the prevention of shearing and guide cutting, one of the biggest headaches on any bar mill.

Billets are generally reduced to bars by either flat and edge, oval and square, diamond and square, or a combination of these methods. Which of these methods gives the best results has been the subject of many discussions. Here again no set formula can be devised for all mills. Each mill is a study in itself. The method to use depends a great deal on the range of the mill, the reductions required, and the size of the billets available. Some mills rolling straight carbon steels might find one method of reduction excellent but this same method might be a disadvantage on some mills rolling nickel or other tight scale steels.

Design of passes is very important in breaking scale but very often a method of reduction which is not the best scale breaker can be used if hydraulic sprays are installed to help break the scale. Hydraulic sprays are a big help in producing bars free from pitting. This applies particularly to bars used for cold drawing. These sprays also are of great assistance in preventing guide cutting as they blow the scale off the bars before it enters the guides and prevent accumulation of scale on the guides.

Guides have been one of bar mills biggest headaches. Most mills in their time have had their share of grief with guide cutting. Some guides work on one mill and the same guide is a failure on others. This is due chiefly to two things: difference in temperature and difference in methods of reduction and rolling.

The relationship of the stock going through the rolls to the guides is very important. The stock and shape of it should be such as to make the guides do as little work as possible. For example take the oval going into the finishing stand for a round. We all know the high oval is much easier to hold up than the blunt oval. Theoretically the blunt oval will give a more uniform section of finished round than the high oval but in practice it does not always work out this way. Very often with the blunt oval material is rolled out of tolerance or guide cut due to the amount of tinkering it is necessary to do with the guides and also to the great amount of guide pressure it is necessary to use in holding the oval up.

What applies to the finishing oval also applies to other stands in the mill. Sometimes the error is made of trying to take too many sizes out of the intermediate stands. You finally get the rolls opened up so far it is hard to fill up the pass properly and the guide must do too much work to hold up the bar. Generally it only takes 5 or 10 minutes to change a pass and this is better than trying to cover too big a range and then lose time due to shearing, guide cutting and poor delivery of bars from one stand to the next.

The setting of rolls is very important. On a continuous mill the rolls should be set at such an elevation that when the bar enters a stand it will take the weight off the preceding delivery guides. If the rolls are not set in this manner there is too much pressure on the guides.

A mill can be made easier to operate by the use of various gadgets such as spindle carriers, hold-down arrangements and twister rolls. Wherever possible rollers should be used to keep the steel from coming in contact with plates.

Bearings are of great importance. In most cases nonmetallic bearings are an advantage over grease bearings — at least that has been my experience. We do not seem to get as much spring as we did with brass and babbit bearings covered with grease. If nothing else, they are certainly a great deal cleaner and the men who have to handle them and work around them like this.

Another item of importance is the physical results on finished bars. Some mills rolling exactly the same sizes show quite a difference in the physical results. Here again there is no set formula that will apply to all mills. Each mill is again a study in itself to find the reductions and temperatures to give the desired results.

In closing it can be said there is no set formula for rolling and heating that is applicable to all mills. It depends on the type of mill, type of product, and the quantity of tonnage the mill is capable of producing. In order to produce tonnage and at the same time quality, each mill must be made a study by itself. It is necessary to continually study each individual mill and continually make improvements. You know a bar mill is never really built until the day you decide to abandon it and begin to tear it down. If a new mill is constructed and no improvements made in this day and age, it will soon be an old mill. Mills must be improved from day to day; the same with furnaces. They must be studied and improved equipment applied in the bottlenecks. This study is a constant job on any bar mill; they are never built — there is always work to be done.

DISCUSSION

PRESENTED BY

B. B. BARGMAN, Fuel Superintendent, Carnegie-Illinois Steel Corporation, Munhall, Pennsylvania.

P. F. KINYOUN, Combustion Engineer, Bethlehem Steel Company, Lackawanna, New York.

C. P. HAMMOND, Superintendent Roll Mills and Billet Department, Atlas Steels, Ltd., Welland, Ontario, Canada.

J. R. GREEN, Manager Steel and Ceramic Division, Brown Instrument Company, Philadelphia, Pennsylvania.

J. L. McHUGH, General Foreman, No. 18 Rolling Mill, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

B. B. Bargman: I am particularly interested in the writer's comments that the purpose of a furnace is to heat steel, not to save refractories. I am reminded of when we first started asking the operators to operate with furnace pressure. Immediately we had considerable objection due to the fact that the refractories

melted. We must recognize that there is an optimum point, not only in the use of fuel but also in the use of refractories, and we must seek a balance.

P. F. Kinyoun: I would like to ask Mr. McHugh how long a preheat zone is in the back of the furnace that he mentions. If you have a 50 ft furnace, is it 10 ft that is back of the flue in the furnace? And also in a two zone furnace what experience have they had with chrome base ramming mixture in hearth of the furnace, if they have such a hearth?

C. P. Hammond: The only question that I have is on non-metallic bearings. I notice that you stated you had less spring. We have all non-metallic bearings but our experience was just a little different. We do know that the non-metallic bearings hold better. We have less pinching to hold size and section, but we did find, very definitely, that we got more spring.

Having started with a 9/16 in. shell, on one particular section, it was necessary to run the rolls tight on the face with the bronze bearings to get a thin edge on the section. However, the non-metallic bearings caused the section to be .010 in. full. By reducing the thickness of the shell to 3/8 in. in thickness, we were able to get size and section with the same depth groove as we originally used when using bronze bearings.

J. R. Green: Mr. McHugh mentioned one point in connection with heating furnace operation which was in contrast with that discussed in Mr. Putich's paper, namely the relationship between furnace temperature and the actual temperature of the steel as prepared for rolling. Mr. Putich's paper outlined a condition where his temperature in the furnace under a wide variety of loads was apparently very close to his actual rolling temperature. This may be due either to furnace design or to his ability to deliver a sufficiently high percentage of the fuel into the preheating portions of the furnace. Unfortunately experience generally would indicate that this is not usually the case; in other words, the so-called soaking zone is actually a heating zone where the furnace temperature must be considerably higher than the temperature of the steel discharged from the furnace in order to get the steel up to the temperature. This involves several additional problems in the control of heating furnaces. As Mr. Putich mentioned, it is possible to position the temperature measuring element in the furnace so that it will correspond to the final discharge temperature of the steel even though the furnace temperature itself is considerably above the recorded temperature. This condition of course holds true only for one loading rate on the furnace. As was also discussed it is possible to measure the temperature of the steel itself rather than the furnace, but this introduces some problems which are mechanical in nature.

Any means of setting the actual furnace temperatures from the temperature of the steel discharged from the furnace is helpful and there are certain methods of automatically setting the desired furnace temperature under heavy and light load condition which will deliver steel at approximately the desired rolling temperature.

J. L. McHugh: The first question was the length of the heating zone in rear of the flue to the stack. In our case 7½ ft back of the flue. We would like to have had 3 or 4 ft more but did not have the room to do it.

The next question is concerning our experience with chrome base ramming mixture in the hearth. Our experience as a whole with this hearth has been good on the biggest part of the hearth. We have two furnaces about 75 ft long, with dry skids a little over half way down the furnace and a rammed bottom from there up to the discharge door, and these bottoms up to a point close to the discharge door have been in for over two years and have caused no trouble, but our experience with that part of the hearth near the pushout and discharge doors was not as good. The furnaces are side discharge and we have worn through the bottom at this point in as little as three to six months, especially at the discharge door where we would wear below the door sill. After experiencing that difficulty we decided to try chrome brick and put in a strip of brick about 5 ft wide and extending back into the furnace about 10 ft from the discharge door on a line with the pushout door. This improved our condition a great deal. A cinder forms on the brick and serves as a protection for the brick but we must remove this cinder at times or it will become too high and causes trouble in pushing out.

Another question was concerning spring on non-metallic bearings. Our experience has shown less spring, although when we first installed them we found a tendency for the bottom roll to climb, especially when the bearings were pulled up pretty tight, and under this condition we had plenty of spring. It was therefore necessary to educate roll crews not to pull bearings too tight, and we installed hold down arrangements on the bottom roll which improved our condition in this respect considerably. The use of fabric bearings along with the removal of the wedges from our housings has reduced our spring.

Concerning the question of the relation of the heating and soaking zone, the manner in which a furnace is to be operated depends a great deal on the tonnage a mill is capable of rolling. In our case we lost heat in going from the heating to the soaking zone. Originally our knuckle was in the neighborhood of 12 in. above the bottom. We raised this to 18 in. which was all we could get and as a result of this change we were able heat considerably more tonnage. On the life of non-metallic bearings, we have had bearings in on our 20 in. roughing which have been in for a year. In fact we had one in for two years that was the maximum. On the 14 in. stands we have had many bearings in for as long as nine months.

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. . . . many variables affect the power requirements of merchant mills, requiring much test data collected over a wide range of conditions . . . . there is need for additional test work and for the collection of such data into usable form . . . .

by W. B. SNYDER

INDUSTRIAL ENGINEERING DIVISION

GENERAL ELECTRIC COMPANY

SCHENECTADY, NEW YORK

▲ MERCHANT-bar and rod mills roll reheated billets into an almost endless variety of products, including small angles and other structural shapes, special sections for the automotive industry, flats, squares, rounds, hexes, concrete bar, and rod for subsequent drawing into wire. There is no clean-cut line of demarcation between the two types, as most merchant mills are arranged to permit rolling rod, and many of the newer rod mills can also produce a variety of merchant shapes. Since the rod mill has perhaps attained a higher degree of specialization than the merchant-bar mill, its development will be discussed first.

ROD MILLS

The development of the rod mill is a record of continuously increasing delivery speeds, higher rates of production, increased flexibility, and improved quality of product. The earlier mills were of the Belgian type. These soon passed out of the picture, except for a few small mills, chiefly in the copper industry. They were superseded by the Garrett mills, which were very flexible and which achieved high production rates by the expedient of multi-strand rolling. One of the latest of these mills, with seven reels and rolling six strands, has produced as much as 35 tons of No. 5 rod per hour, at a delivery speed of 1600 fpm. The power consumption of these mills when rolling No. 5 rod from 4 in. x 4 in. billets is typically from 150 to 200 kwhr per ton, the lower figure applying on non-metallic bearings and the higher figure on plain bearings.

In addition to high power costs, the Garrett mill has high labor cost due to the low delivery speed and the necessity of manual manipulation. It is thus a poor competitor with the more modern types. The last Garrett type rod mill to be installed in a domestic steel plant was put into service in 1928.

The development of the continuous mill more or less paralleled that of the Garrett mill. This mill might more accurately be called the single-drive continuous mill, as its distinguishing feature is that all stands are geared together. The term "continuous" might better be applied more generally to any mill in which the product of fpm times pass area is the same for all stands or, in other words, in which the instantaneous flow of metal, in pounds per minute, is the same for all stands.

The single-drive continuous mill was introduced in England in 1862, but it was not a factor in rod produc-

Presented before A. I. S. E. Annual Rolling Mill Conference, Pittsburgh, Pa., May 8, 1944

tion until the invention of the twist guide by Morgan, which made multi-strand rolling possible on mills of this type.

Figure 1 shows the layout of one of the two single-drive continuous rod mills installed in 1937 in the Joliet Works of the American Steel and Wire Company. These two mills are the latest of their type. In general, the layout will also apply to the earlier mills, aside from such important differences as the number of stands, the type of bearings, and the number and arrangement of reels.

These mills are extremely efficient producers. Their tonnages are high and their labor and power costs are low. Delivery speeds are typically from 3000 to 4000 fpm, and power consumption is from 65 to 70 kwhr per ton. The average production is usually figured on about 85 per cent of the theoretical value obtained with all stands 100 per cent full at all times. A good crew can exceed this rate without difficulty.

The single-drive continuous mill has, however, about reached the final stages of its evolution. It has become a highly specialized tool for the efficient production of No. 5 rod, but has obtained its efficiency only at the sacrifice of flexibility. It may thus be regarded as an offshoot of the main line of development toward more flexible mills. Only a few large producers can utilize such a mill to its fullest efficiency, and it is doubtful if many more of them will be installed.

MILL FLEXIBILITY

Flexibility in a rod or merchant mill is the ability to roll a wide variety of finished products from a few sizes of billets. The more flexible the finishing mill is, the more efficiently the billet mill can operate, as any reduction in the variety of billets rolled decreases the

Figure 1 — Layout of a single drive 11 in. two-strand continuous rod mill installed in 1937.

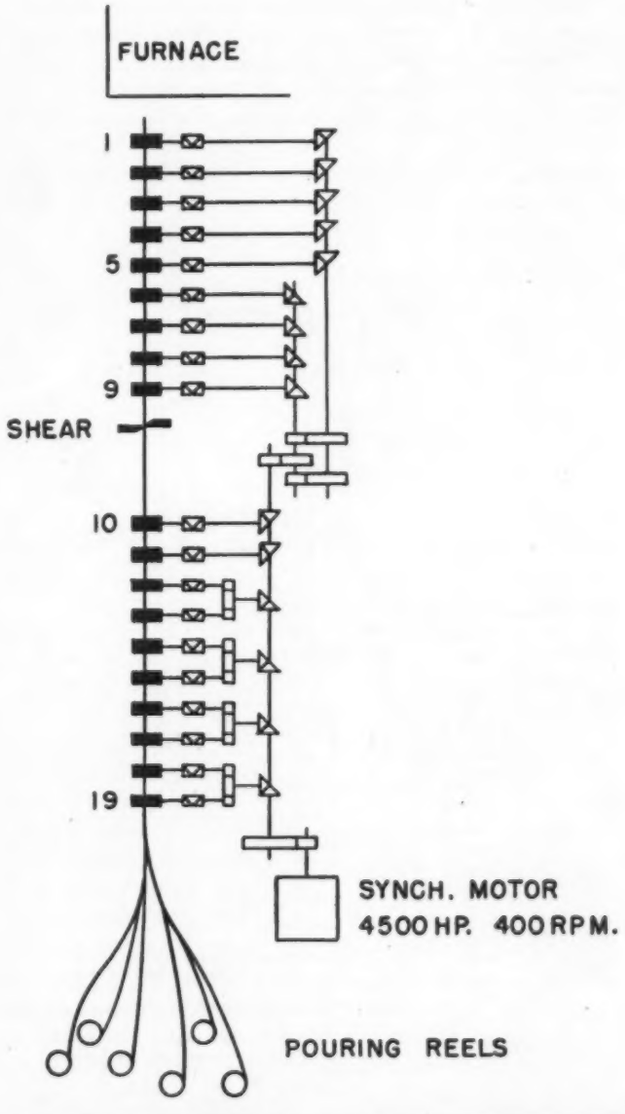
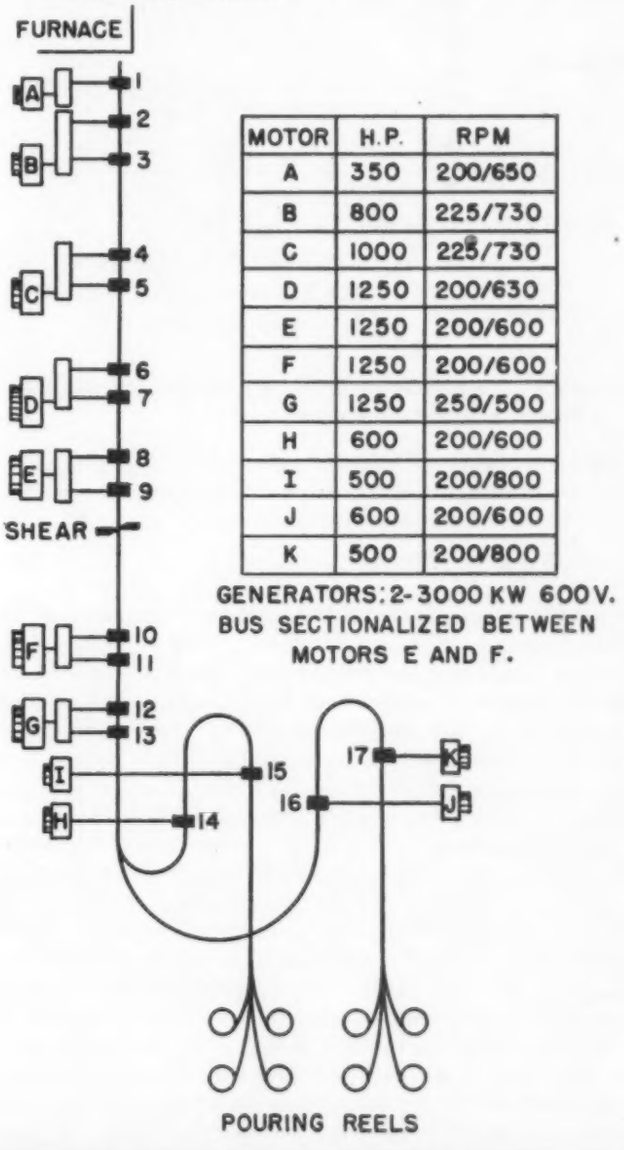
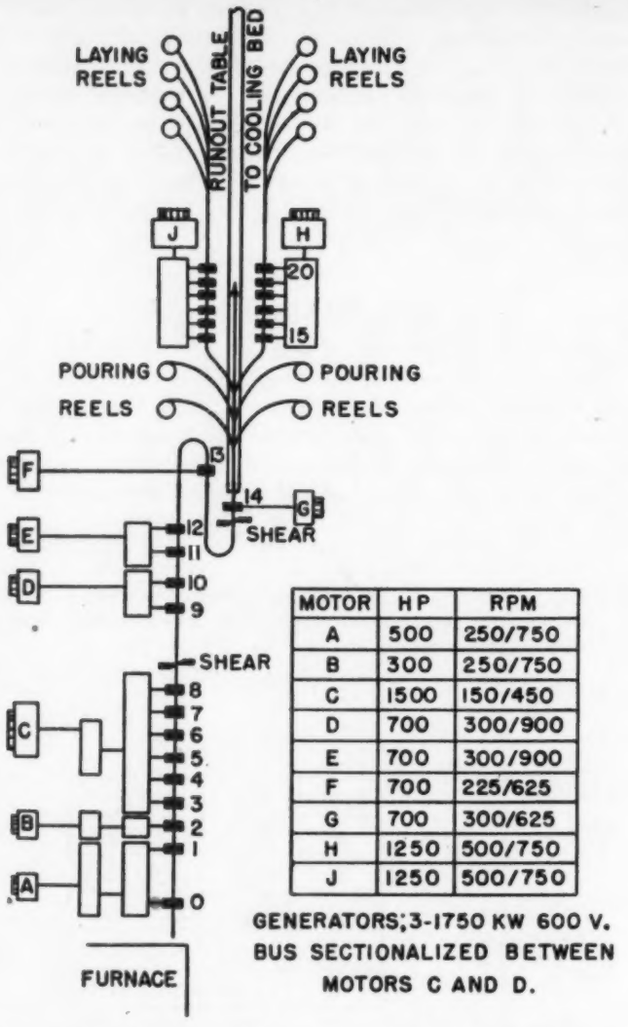


Figure 2 — Recent 13 in. mill installed for coarse rod, using four strands through the straightaway and two finishing sections.

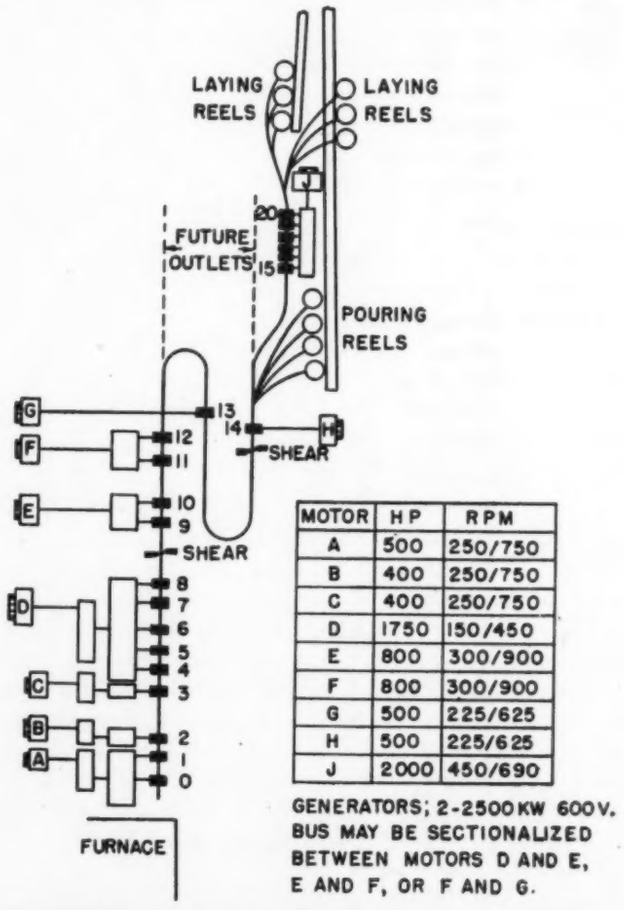


MOTOR	H.P.	RPM
A	350	200/650
B	800	225/730
C	1000	225/730
D	1250	200/630
E	1250	200/600
F	1250	200/600
G	1250	250/500
H	600	200/600
I	500	200/800
J	600	200/600
K	500	200/800



MOTOR	HP	RPM
A	500	250/750
B	300	250/750
C	1500	150/450
D	700	300/900
E	700	300/900
F	700	225/625
G	700	300/625
H	1250	500/750
J	1250	500/750

Figure 3 — Combination 10 in. four-strand rod and merchant mill installed in 1937. ↑



MOTOR	HP	RPM
A	500	250/750
B	400	250/750
C	400	250/750
D	1750	150/450
E	800	300/900
F	800	300/900
G	500	225/625
H	500	225/625
J	2000	450/690

Figure 4 — Another 10 in. combination rod and merchant mill, using only one finishing train and designed for three strands throughout. →

time for roll changes and the amount of steel that must be carried in stock in billet form.

For a mill to roll different products from one size of billet requires a variation of the reductions per pass or a change in the number of passes. The single-drive continuous mill obtains its limited flexibility by changes in the number of passes, as its reductions per pass are fixed by its gear ratios. To obtain any appreciable degree of flexibility in a mill, it is necessary to vary the reductions per pass, which will require corresponding changes in the ratios of entry to delivery speeds in the various stands. There are three ways by which these speed changes can be made possible: (1) by introducing loops in the path of the metal, with sufficient storage in the loop to accommodate any over or under-feeding; (2) by interrupting the mill so that at one or more points a piece has completely left one stand before it enters the next; and (3) by relative speed adjustment between different stands or different groups of stands. The first method is incorporated in the Garrett mill, at the cost of lower finishing temperatures, greater temperature differences between front and rear ends of a piece, and large floor space. The second method is incorporated in the "cross-country" mills, which are widely used for producing rails, structural shapes, and heavy merchant bars, but which cannot well handle the long pieces of small cross-section produced when rolling rod and small merchant products. The third method is incorporated in the modern high speed rod mill, by breaking the mill into several groups of stands, each group driven by its own adjustable speed motor. It should be noted that, although the modern rod mill incorporates loops in the path of the metal, these loops are introduced to improve the accuracy of section and not to compensate for speed differences. It is practically impossible to set up a straight-away continuous portion of a mill so that there is neither over-feeding nor under-feeding throughout the group of stands. Since any appreciable over-feeding will result in a loop forming between the stands and growing until a cobble results, in practice the rollers will set the mill up for a slight under-feeding. Thus the metal is in tension between stands, and some of the reduction is produced by stretching. The ends of the bar are not subjected to as much stretch as the central portion, and thus overfills are likely to be produced. It is possible to reduce these inaccuracies by subsequent rolling without tension, and therefore the modern mill incorporates a few "free" passes in which there is no back or forward tension.

A rod mill designed for an unusual degree of flexi-

bility has recently gone into service. The arrangement of this mill is shown in Figure 2. The straight-away section of the mill consists of 13 stands, the first with a separate motor drive and the remainder driven in pairs. The straight-away portion is opened up between stands 9 and 10 to provide for the installation of a crop shear and to permit a small loop to relieve tension.

The mill is 4-strand throughout the straight-away portion. Then the strands diverge into two pairs, one going through one finishing section and the other through another. Each finishing section consists of two individually driven stands followed by four reels. The maximum finishing speed of the mill is approximately 2500 fpm.

All the motors on this mill are 600 volt direct current machines with exceptionally wide speed ranges by field control, the maximum being 4:1 on the finishing stands. In addition, the direct current bus is split between motors E and F, permitting still wider relative speed adjustment between the roughing and intermediate sections by operating these sections at different voltages.

This mill is used primarily to produce rounds $\frac{5}{16}$-$\frac{3}{4}$ in. in diameter, from $2\frac{1}{2}$ in. square billets weighing approximately 600 lb.

A still more diversified line of products can be rolled on the combination rod and merchant mills recently installed. Figure 3 shows the layout of a 10-inch 4-strand mill of this type installed in 1937 at the Sparrows Point plant of the Bethlehem Steel Company. The straight-away section on this mill comprises 13 stands, opened up between stands 8 and 9 to permit the installation of a shear and to provide a loop for relieving tension. Five adjustable speed, direct current motors drive this section.

Following the straight-away section are two individually driven looping stands. The second looping stand (No. 14, since the first stand is No. 0), forms the mill outlet for merchant bars which may be carried to a hotbed by the runout table with individually driven rolls, or for heavy rods which may be delivered to the pouring reels.

Smaller rods are finished in two parallel 6-stand continuous finishing trains, each group driven by an adjustable speed motor. Each finishing train is double-strand and delivers its produce to four laying reels. This mill can and frequently does roll two different products simultaneously on the two finishing trains. In fact, one finishing train can be kept busy on No. 5 rod, which forms the major portion of the mill's production, while the other train is shutting down for roll changes, restarting for rolling another product, etc. The two motors on the finishing trains are provided with magnetic control to make this shutting down and restarting possible without disturbing the remainder of the mill.

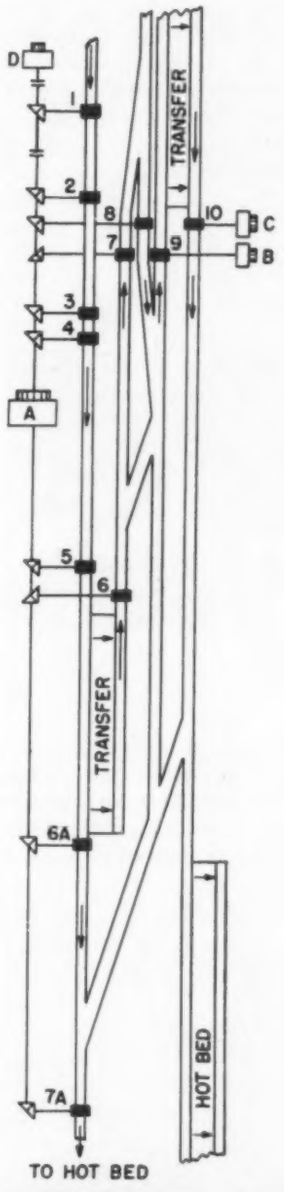
It will be observed that this mill is designed on the premise that it is better to keep the finishing speed of the mill up near the top of the rating and to obtain flexibility and diversity by lowering the speeds in the earlier stands. For instance, the motors driving the roughing and intermediate sections have 3:1 speed ranges by field control, and still further speed reduction is provided by a bus split between motors C and D, permitting operation at two voltage levels.

The range of finishing speeds, at normal bus voltage, is 865-1800 fpm out of stand 14 and 2750-4100 fpm out of stand 20.

That this mill achieves flexibility without sacrificing tonnage is shown by the fact that it has maintained a production rate of over 50 tons of No. 5 rod per hour for a full turn.

A later mill of this type, installed in 1942 in the Pittsburg, California, plant of the Columbia Steel Company, is shown in Figure 4. While this mill at first glimpse closely resembles the Sparrows Point mill with one finishing train and the hot runout table omitted, there are some interesting modifications. The mill is 3-strand throughout and additional flexibility is incorporated by a separate drive for stand 3. Provision is also made for a bus split between either motors C and D, D and E, or E and F.

This mill was installed to produce rod from $\frac{1}{2}$ inch to No. 5, but provisions were incorporated in the design to permit a great increase in the range of products if



18"-14" MERCHANT MILL

MOTOR	H.P.	RPM
A	5600	60/180
B	1500	110/300
C	1500	110/300
D	900	150/300

NOTE: MOTOR D OPERATED AS REVERSING DRIVE WHEN USED

Figure 5 — Layout of 18-14 in. merchant mill of cross-ountry type. A separate optional drive permits No. 1 stand to be operated as a reversing rougher.

this should prove desirable in the future. Stand 14 may serve as a future outlet for merchant-bar sections which may be looped, and additional stands may be added to the straight-away section for small structurals and other products on which looping is not permissible.

MERCHANT BAR MILLS

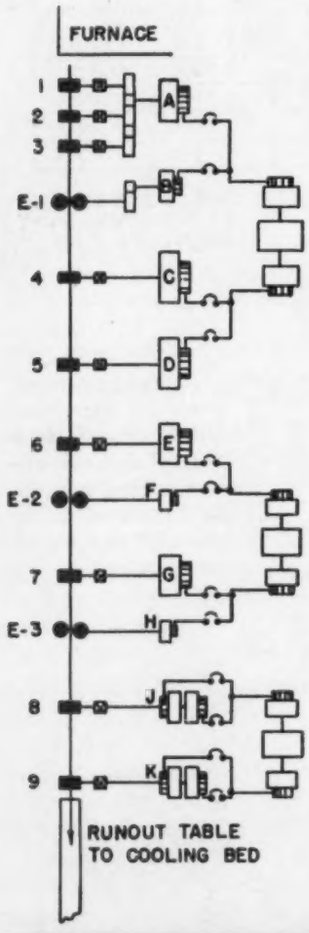
The development of the merchant-bar mill has been so thoroughly described by R. E. Beynon in his article in the December 1943 issue of THE IRON AND STEEL ENGINEER that there remains little more to be said. The trend of the development, as in the rod mill, is toward more and more flexibility. The need for flexibility is probably greater in the merchant mill as it rolls a wider diversity of products than the rod mill. On the other hand, the increased section area on the merchant mill means that there is less need for high delivery speeds and that the temperature drop due to looping or end-for-end rolling is less than on the rod mill. Thus the heavier mills, in particular, can obtain their needed flexibility by end-for-end rolling.

Figure 5 shows the layout of the 18-14 in. merchant mill at the Indiana Harbor plant of the Youngstown Sheet and Tube Company. This was installed as a cross-country mill with a continuous roughing section having all stands driven by one motor. Some time after installation an interesting adaptation was made. The mill was arranged to permit unclutching the first stand from its normal drive and clutching it to a separate driving motor. Under these conditions, stand 1 was arranged to operate as a little reversing mill and is in effect used to make small billets out of large ones. Thus more products can be rolled from one size of billet, and the flexibility of the mill is thereby increased.

In spite of the popularity of the cross-country mill, there is a definite trend toward high speed continuous merchant mills with individually driven stands. The tendency is also to use a number of vertical stands in the mill, thus avoiding twist guides at these stands.

Paradoxically, the merchant mill which most closely represents the present trend toward flexibility was installed in 1924. This is the 14 in. merchant mill at the Aliquippa Works of the Jones and Laughlin Steel Corp. Figure 6 shows the layout of this mill. It will be noted that the mill consists of nine horizontal and three vertical stands and that, aside from the first group of three, each stand is individually driven from an adjustable speed, direct current motor. Furthermore, each of the motors on the last two stands is supplied from an individual generator, and the other motors are arranged two to a generator. Thus the mill has an unusually high degree of flexibility, as the individual motor speed ranges are almost unlimited.

This mill has a maximum delivery speed of approximately 3000 fpm. The total capacity of its motors is 15,750 hp, making it the most highly powered merchant mill in the world.



MOTOR	HP	RPM	GEN. KW
A	3000	200/360	2500
B	750	360/860	
C	1700	90/140	2500
D	1700	90/205	
E	2100	150/310	1800
F	200	360/860	
G	2100	150/460	1800
H	200	360/860	
J	2000	210/680	1800
K	2000	260/800	1800

Figure 6 — Although installed in 1924, this 14 in. merchant mill well illustrates the flexibility desired in such a mill.

POWER CONSUMPTION

Power records on individual products of the merchant mill are rather inconsistent, due to the great diversity of small orders rolled. However, average readings are reliable, and the following may be of interest.

Records of a little over a year's operation on a 10-inch merchant and rod mill with straight-away roughing and intermediate sections and four looping finishing stands have shown an average monthly production of about 15,000 tons of rods and bars. The total power consumption of main and auxiliary drives averages about 125 kwhr per ton for rods and about 60 kwhr per ton for bars. The rods produced are mostly No. 5, and the bars are primarily rounds, hexes, and squares of 1-inch size.

Over a period of three months, a 12-inch merchant mill of the cross-country type, with a semi-continuous roughing section and a continuous finishing train, produced a little over 122,000 net tons. This covered a very diversified line of products, including $1\frac{1}{32}$-$3\frac{1}{4}$ in. diameter rods, $1\frac{1}{32}$-$2\frac{5}{16}$ in. angles, $1\frac{1}{4}$-3 in. hexagons, and $1\frac{5}{16}$-3 in. squares. The average power consumption was 23.2 kwhr per ton for the main drives and 16.2 kwhr per ton for the auxiliary drives.

Fourteen months of operation on a 16-14-12 in. merchant mill with straight-away semi-continuous rougher and six cross-country finishing stands show an average production of a little over 24,000 tons per month. This figure covers rounds $1\frac{1}{16}$-$4\frac{1}{2}$ in. in diameter, squares 1-$4\frac{7}{8}$ in., and flats from $1\frac{1}{2}$ x $\frac{1}{4}$ in. up to 8 x $2\frac{1}{4}$ in. Over this period the total power consumption for main and auxiliary drives averaged 38.3 kwhr per ton.

SELECTION OF ELECTRICAL APPARATUS

From the point of view of their electrical apparatus, the mills just discussed fall into two entirely separate groups — namely, the single-drive continuous mill, and the continuous or semi-continuous mill with several adjustable speed drives.

Single-drive continuous mills — The uniform loads of the single-drive continuous mills make them ideally suited to synchronous motor drives. Since synchronous motors are cheaper and more efficient than wound rotor motors previously used and, in addition, have the ability to correct power factor, they have been applied on the last four mills of this type installed. Each of these mills is driven by a 4500 hp motor. They are all adequately powered. In fact, at least one of them has been changed over from 2-strand to 3-strand rolling without any change in the driving motor.

Two of the recent mills have non-metallic bearings which originally were lubricated entirely by water. The starting torque requirements on these mills were rather high and at times it was necessary to jog the motors both forward and reverse at full voltage to break the mill away. The motor torques under these conditions were about 70 per cent of full load torque. Later the practice of greasing the bearings just before a shutdown was adopted, and this has eliminated starting difficulties.

The other two mills are provided with roller bearings, and start without difficulty at a motor torque of about 60 per cent of full load torque.

All mill type synchronous motors are designed for full voltage starting, and should be started in this way provided the high inrush current is not objectionable. If reduced voltage starting must be used, the reactor method will usually be found adequate. For those few cases where reactor starters will not provide sufficient torque without objectionable current peaks, autotransformer starting may be used.

It is desirable, although not absolutely essential, to provide reversing control on the motors of a single-drive continuous mill, to assist in removing cobbles and lining up roll-necks.

The motors for the single-drive continuous mills will usually be located on the mill floor, and thus should have complete enclosing covers to keep them clean. The use of these covers will require that the motors be forced ventilated. Where cooling water is available, a recirculating ventilating system with a surface air cooler is most desirable. In most cases, the air cooler can be supported underneath the motor frame. Usually no separate blower will be needed as the motor will have inherent fan action sufficient to circulate its own ventilating air.

Multi-drive mills — When selecting the drives for the more flexible forms of mills, it was formerly necessary to consider whether a-c or d-c adjustable speed motors would be used. Fortunately, this question no longer arises. The industry has become accustomed to the flexibility of the direct current drives and will no longer accept the limitations on speed range, speed regulation, and fineness of control imposed by the a-c drives.

The first step in the selection of drives is to lay out

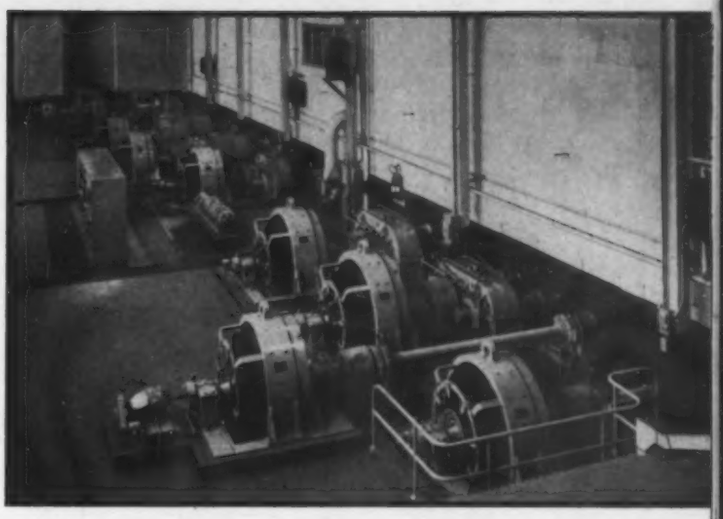
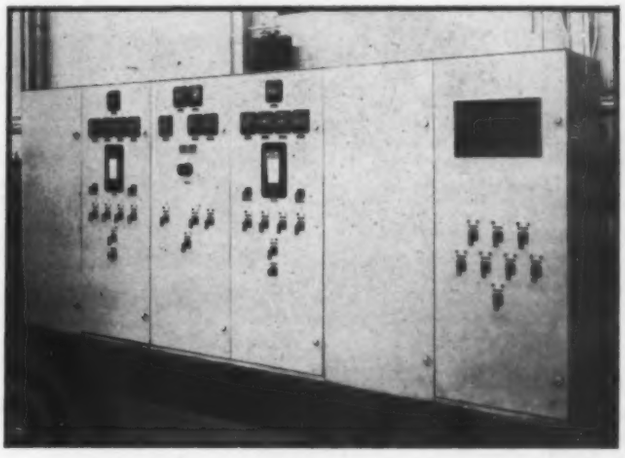


Figure 7 — Motor room of 13 in. four-strand rod mill. Finishing stand motor in foreground has pilot generator for controlling reel speed.

▲

Figure 8 — Duplex board controlling 600 volt d-c motors and generators of 13 in. four-strand rod mill.



the limiting rolling schedules — and there are probably dozens of them — to determine the power requirements and operating speeds of each motor on each schedule. When these results are combined it is often found that on some or all drives the desired speed ranges are wider than can be obtained on motors of the sizes needed. Then it is necessary to redraft the schedules or to increase the operating speed ranges of the motors. The operating speed range may be increased by varying the voltage applied to the motor armature, or by going to double armature motors.

As a result of this procedure, which often taxes both the ingenuity and the dispositions of the mechanical and electrical designers, the desired motor sizes and speed ranges are established. In case the motors must operate at different voltage levels to meet the speed requirements of certain schedules, it should be borne in mind that the available motor horsepower will be reduced in direct proportion to the reduction in voltage. Inspection of the schedules will determine where to locate the bus sectionalizing switches which permit operation at different voltage levels. Bus sectionalizing is an inexpensive way of increasing the flexibility of a

mill, provided it does not increase the number or total capacity of the generators.

The capacity of the d-c generators supplying the mill is determined from the requirements of the limiting rolling schedules. On a rod mill the generators are usually capable of supplying the motors with a diversith factor of from 80 per cent to 85 per cent. The merchant mills show much more variation in this respect, the factors ranging from 50 per cent to 100 per cent on mills now installed.

STARTING OF D-C MOTORS

Many of the earlier mills have magnetic starting equipment for all main roll drive motors. This apparently came about because in several cases one source of direct current power was used to supply two adjacent mills, and because it was thought desirable to arrange the mills to permit shutting down and restarting any drive without disturbing the others. The latter feature has proven unnecessary for any drives other than those of parallel or alternate finishing sections, and in most cases it can be demonstrated that for two mills individual sources of power with Ward-Leonard starting are more economical than a common power supply with magnetic starting. Consequently, the modern mills are all arranged for Ward-Leonard starting, possibly with magnetic control for one or two motors. For example, the mill shown in Figure 3 has magnetic control on motors H and J, driving the parallel finishing trains.

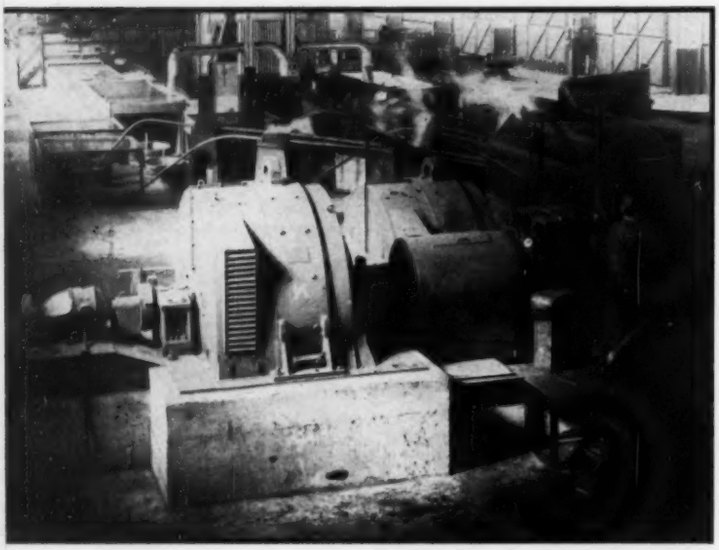
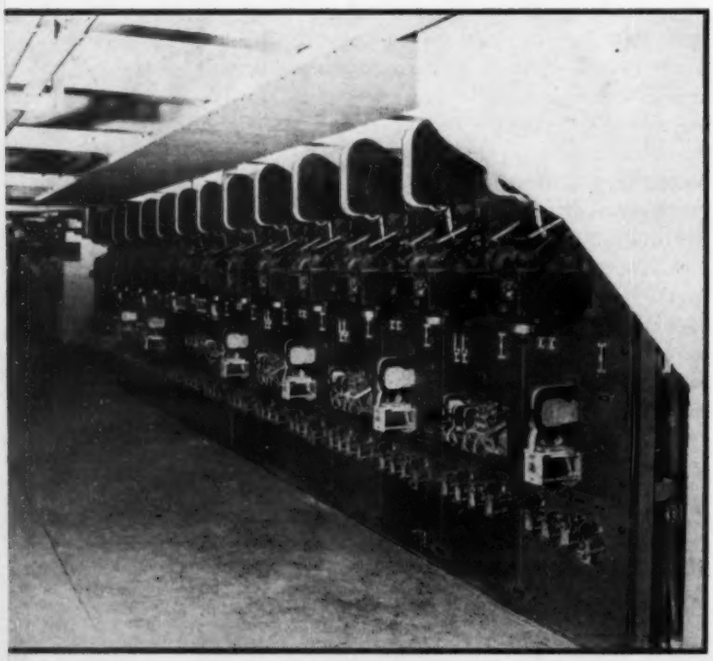


Figure 9 — Finishing stand motors for one of two parallel finishing trains in a 13 in. four-strand rod mill. Motor on left has pilot generator for controlling reel speed.

▲

Figure 10 — Circuit breaker panels for 600 volt d-c generator and motors on one bus section of 13 in. four-strand rod mill.



MOTOR CHARACTERISTICS

Much progress has been made in the last few years in the development of adjustable speed d-c motors for multi-drive continuous mills. The stable performance of modern mills as compared with the "touchy" behavior of some of the older ones demonstrates this conclusively. This improvement in motor characteristics is the result of studies of the action of continuous tube mills initiated about ten years ago. These have shown that the transient speed characteristics of a motor have much greater effect on good continuous mill operation than do the steady-state characteristics such as speed regulation. For example, when the load on a d-c motor is changed, the motor speed will change from a steady value to an oscillation about the speed corresponding to the new load condition. This oscillation will occur even if the motor has perfect speed regulation — that is, has no change in speed from no load to full load conditions. While this oscillation is quickly damped out, during its existence it momentarily upsets the stability of the mill. Consequently, the smaller the amplitude and the shorter the duration of the oscillation, the better the motor performance will be.

By definition, the impact speed drop of a motor is the drop in speed during the first swing after full load is applied, and the speed recovery is the rise in speed from the minimum value to the steady-state condition. It is obviously desirable to reduce the impact speed drop, because this will mean less disturbance to the rolling operations. Also, speed recovery should be minimized since it prolongs the disburbance. Thus, a motor with high impact speed drop and excellent speed recovery (or good speed regulation) may be poorer in performance than a motor with low impact speed drop and poor speed regulation.

Motors with improved transient stability have been applied on several of the more recent mills with eminently successful results. While these motors are somewhat more expensive than those of standard design, their improved performance is well worth the difference in price.

As a result of these developments speed regulators, which have been widely used on previous mills, have not been applied on any of the more recent installations. It is true that most of the newer mills have used series exciters to improve motor speed regulation, but these have been purchased primarily on the basis that they

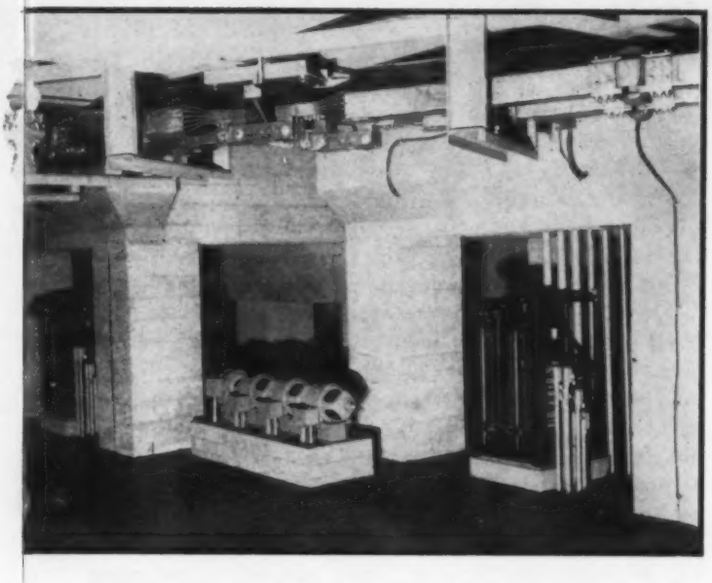


Figure 11 — Bus joining circuit breaker panels for two 600 volt d-c bus sections of 13 in. four-strand rod mill.

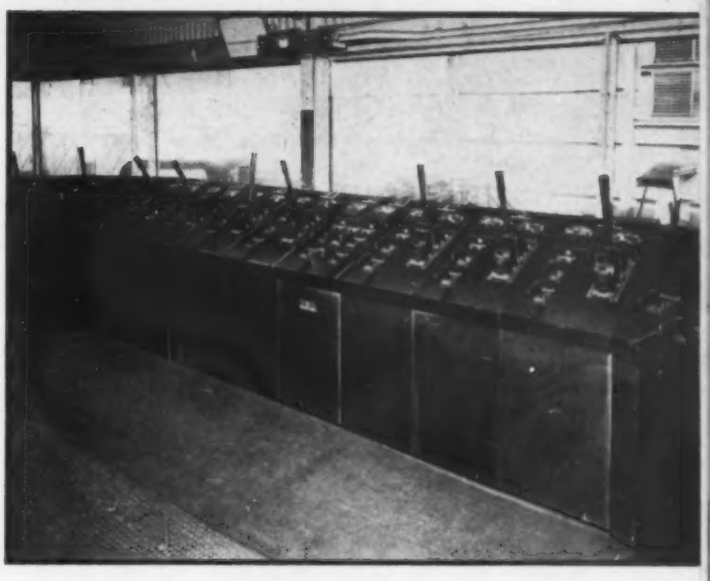


Figure 12 — Control desk in pulpit of 13 in. four-strand rod mill.

are simple and inexpensive, and that any benefit obtained from them is worth while. However, it is likely that the series exciters can be taken out of service on the newer mills without producing any disturbance that the operators would be able to detect.

VOLTAGE REGULATION

It is essential that the motors of a multi-drive continuous mill be supplied from a bus having excellent voltage regulation, if good mill performance is to be obtained. This is true on modern mills and is still more true on mills having motors of older design. On some of the older mills, it is likely that most of the evils attributed to poor speed regulation would disappear if the motors in question were supplied from a bus equipped with a good voltage regulator.

It is the present practice to equip the direct current buses supplying continuous mills with voltage regulators which can hold a value of voltage adjustable over the full range required for mill operation. In case the bus is sectionalized, it is usual to provide a voltage regulating equipment for each bus section and to control from it all generators supplying that section. In case the sectionalizing switches are closed and the bus operates as one section, all generators are put under the control of one voltage regulator.

MOTOR ACCESSORIES

The adjustable speed, direct current motors are normally provided with tachometer equipments to give accurate indication of motor speed, motor operated field rheostats to cover the full range of speed adjustment, and vernier rheostats for incremental speed adjustment. The vernier rheostats are usually manually operated, as the operators like the "feel" of a manually operated device. However, for some special conditions, motor operated vernier rheostats are preferred.

CONTROL FEATURES

The control features of these mills have now become well standardized. The generator line panels will include heavy duty air circuit breakers in both sides of the line. The motor line panels will provide circuit breakers or contactors for line and dynamic braking service. The usual Ward-Leonard interlocking, which prevents connecting any machine to the bus unless bus and machine voltages are zero, is provided. This interlocking, of course, does not apply on motors equipped with magnetic starters. Over-current protection for each machine and loss of field and overspeed protection for each motor are included.

Starting is accomplished by controlling the fields of the d-c generators, usually by means of a motor operated rheostat operating in the field of a generator exciter. By these means the voltage of all generators connected to the bus may be raised smoothly from zero to the desired operating figure, with the voltage regulator automatically taking control at some intermediate voltage and then holding a voltage corresponding to the rheostat setting. Normal shutdown is accomplished by reducing the bus voltage to zero. Emergency stopping is obtained by disconnecting the motors from the bus and applying dynamic braking.

The generator field control also provides forward and reverse jogging features for whatever motors are connected to the d-c bus, when the rheostat controlling the bus voltage is in the zero voltage position.

The mill drives are operated from a control desk located in a pulpit overlooking the mill. This desk will have a section for each motor, mounting an ammeter, a tachometer, a circuit breaker control switch, a main rheostat control switch, and a mechanis, for vernier rheostat operation. Usually this mechanism will consist of a hand operated lever which serves both to make

small adjustments in speed and to indicate when the rheostat is approaching the end of its travel. However, on some mills some of the roughing stands are so closely coupled that only the roller on the floor can observe the necessity for speed adjustment. In these cases it is customary to use motor operated vernier rheostats controlled both from the floor and the pulpit, and equipped with selsyn devices to indicate rheostat position to the pulpit operator. The operating station on the floor will usually include motor ammeters as well as vernier rheostat control switches, as often the need for speed adjustment on closely coupled roughing stands can be determined only from line ammeter indications.

The pulpit desk will also include a generator section which will provide for each section of the 600 volt bus a bus voltmeter, a circuit breaker control switch, a control switch for normal starting and stopping, a control switch for forward and reverse jogging, and an emergency stop push button station.

Modern control desks require about 16 inches of length for each motor. While these are improvements on the previous desks, which required at least 24 inches per motor, there is still room for improvement in this respect. A mill with ten drives now requires a desk over 13 feet long, which will put the operator through a foot-race when making final adjustments on a new rolling schedule.

MERCURY ARC RECTIFIERS FOR ROD AND MERCHANT MILLS

To date, all the d-c motor driven merchant-bar and rod mills have obtained their power from motor-generator sets. However, as was pointed out to the Association of Iron and Steel Engineers in Chicago several years ago, the mercury arc rectifier is well adapted to the requirements of small merchant-bar and rod mills. It is both an efficient and a reliable source of d-c power and at present is inferior to the motor-generator set only in flexibility.

The rectifier can be economically arranged to provide several values of bus voltage by changing taps on its transformer, and to hold the voltage constant at the desired value by means of a voltage regulator. It is also fairly inexpensive to provide grid control which will permit the equivalent of Ward-Leonard starting, so long as the mill starts empty and accelerates quickly to normal voltage. However, if smooth adjustment of bus voltage is required over a wide range and without shutting down the mill, either load ratio control must be provided on the transformer or an induction regulator must be installed ahead of the transformer. Furthermore, the rectifier is not adapted to reversing, so that motor armature or field reversing features will be required in case it is necessary to provide jogging or running in the reverse direction.

POWER REQUIREMENTS

There are several methods of calculating the power requirements of main-roll drives. One method involves the use of formulas which take into acount many factors, such as the change in area, the speed of the rolls, the arc of contact, the roll pressure, the temperature of the metal, etc. This method is somewhat difficult to use, but has proved extremely accurate when constants obtained by test on similar mills have been incorporated in the process.

A simpler and more widely used system is the strictly empirical one of recording the load on an actual mill, plotting the results in the form of a power curve, and then using this curve as a source of load data for the rolling of a similar product. The methods of obtaining, recording, and utilizing the data for this system were thoroughly described before the Association of Iron and Steel Engineers by H. A. Winne in 1932 and need no further explanation here. While this system may not

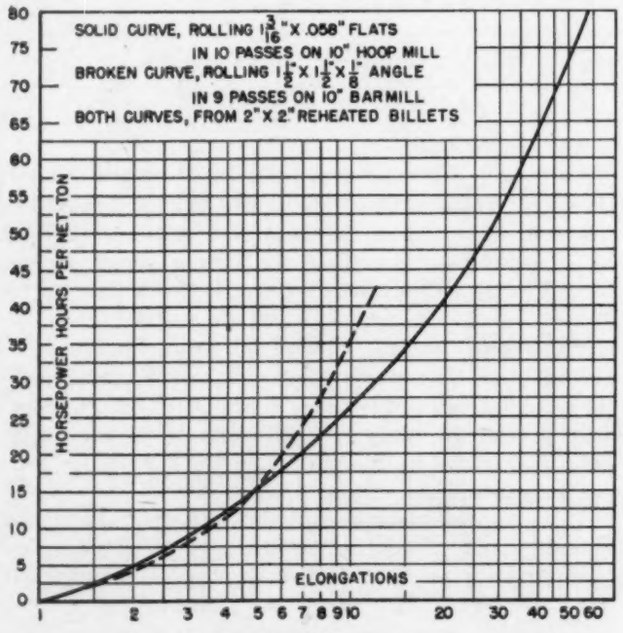

SOLID CURVE, ROLLING 1 3/16" X .058" FLATS IN 10 PASSES ON 10" HOOP MILL
BROKEN CURVE, ROLLING 1 1/2" X 1 1/2" X 1/8" ANGLE IN 9 PASSES ON 10" BAR MILL
BOTH CURVES, FROM 2" X 2" REHEATED BILLETS
HORSEPOWER HOURS PER NET TON
ELONGATIONS
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80
1 2 3 4 5 6 7 8 9 10 20 30 40 50 60

Figure 13 — Power curves showing variation of rolling work with shape of section.

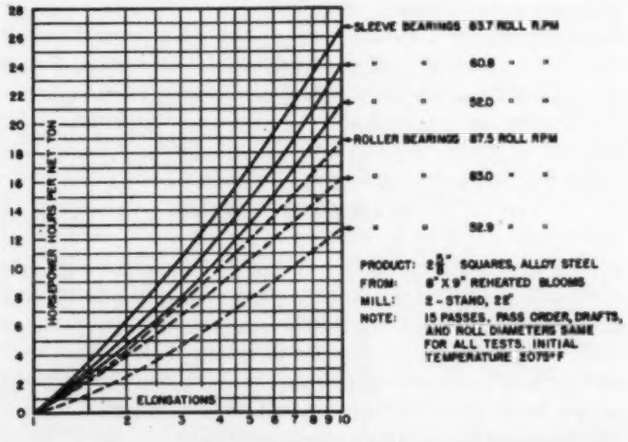

SLEEVE BEARINGS 83.7 ROLL R.P.M
" " 60.8 " "
" " 52.0 " "
ROLLER BEARINGS 87.5 ROLL RPM
" " 83.0 " "
" " 52.9 " "
HORSEPOWER HOURS PER NET TON
ELONGATIONS
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28
1 2 3 4 5 6 7 8 9 10
PRODUCT: 2 3/8" SQUARES, ALLOY STEEL
FROM: 6" X 9" REHEATED BLOOMS
MILL: 2 - STAND, 28"
NOTE: 15 PASSES, PASS ORDER, DRAFTS, AND ROLL DIAMETERS SAME FOR ALL TESTS. INITIAL TEMPERATURE 2075°F

Figure 14 — Power curves showing variation of rolling work with mill speed and the effect of roll neck bearings.

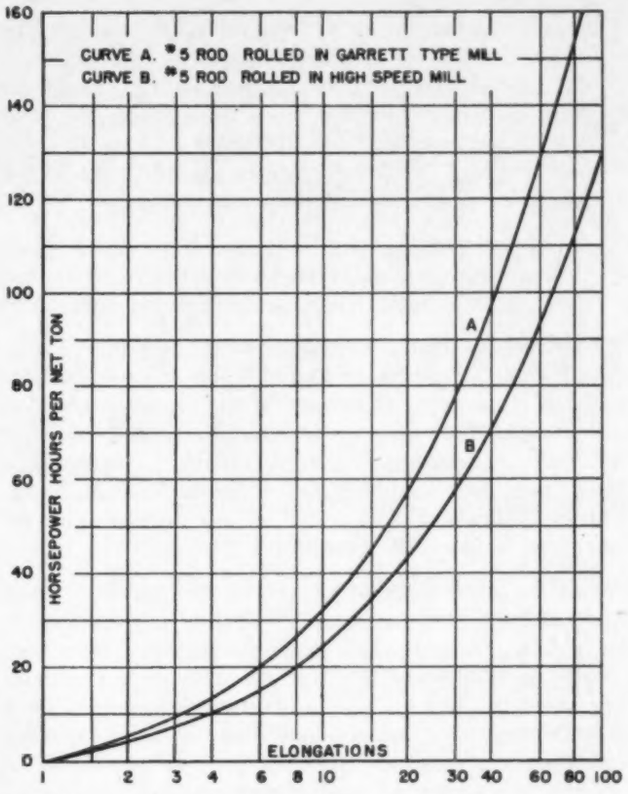


Figure 15 — Power curves showing variation of rolling work in mills of different types.

be as accurate as the one previously mentioned when data are extrapolated to new mills, it has proved adequate for all practical purposes. The motor sizes for many successful mills have been determined by this method of calculation.

In any case, both methods depend on actual test results, and the more nearly the test conditions agree with the rolling schedule to be calculated, the more accurate the results will be.

The modern merchant-bar or rod mill rolls a wide variety of products. Thus, in order to calculate the power requirements of such mills accurately, it is necessary to have access to a large amount of test data. A consideration of a few typical power curves will demonstrate this necessity.

The power curves in Figure 13 show how the power requirements may vary with the section rolled. Here identical billets are rolled on similar mills at about the same speed, one to a $1\frac{1}{2}$ in. x $1\frac{1}{2}$ in. x $\frac{1}{8}$ in. angle and the other to a $1\frac{3}{16}$ in. x .058 in. flat. It takes much more power to roll the angle than it does to reduce the flat to the same cross section, because of the amount of "forming" required by the angle, and the higher roll friction on the angle section.

The curves in Figure 14 are very interesting. During the tests which these curves represent, identical billets were rolled on schedules which differed only in mill speed, some with plain bearings on the mill rolls and others with the plain bearings replaced by tapered roller bearings. These curves not only illustrate graphically how much bearing friction may be reduced by the use of anti-friction bearings, but also give evidence on a controversial subject. The idea that rolling work varies with the speed of rolling, or "rate of deformation," has not yet received full acceptance. These tests, while perhaps not sufficiently extensive to establish quantitative figures, are rather definite indications that the rolling work does increase with the speed.

The curves in Figure 15 show how the type of mill may affect the power requirements. Both of these curves cover the rolling of No. 5 rod from $1\frac{3}{4}$ in. x $1\frac{3}{4}$ in. billets, but one curve is made from tests on a Garrett type mill and the other from tests on a modern high speed mill. In spite of the fact that the rate of rolling on the high speed mill is about twice that in the Garrett mill, the Garrett mill required more power because of the additional cooling of the metal.

It will be apparent from these few examples that there are many variables affecting the power requirements of a mill. To determine these requirements accurately requires test data taken over a wide range of conditions. I am sure that no single organization connected with the steel industry has all the test data it believes desirable, and I suspect none of them feels that the data it possesses covers even the bare essentials.

If such data are of value to the industry, they can be obtained primarily from tests on the later mills and secondarily from records of previous tests as incorporated in power curves in the possession of the steel plants and the equipment manufacturers. The present interest in merchant-bar mills to be installed after the war is an indication that this information is needed. If so, what better method is there of accumulating and publishing these data than by having the work undertaken by the Rolling Mill Committee of the Association of Iron and Steel Engineers?

BIBLIOGRAPHY

Selection of Motors for Main Drives on Merchant, Bar, and Rod Mills by C. B. Huston, 1928 Proceedings of A. I. S. E.

Bar Mills and Bar Mill Roll Design by Ross E. Beynon, 1943 Proceedings of A. I. S. E.

New Continuous Rod Mills, American Steel and Wire Company, Joliet, Ill., 1937 Proceedings of A. I. S. E.

Drives and Control for a Modern Rod Mill by R. H. Wright and B. J. Auburn, 1937 Proceedings of A. I. S. E.

New Rod Mill at Maryland Plant of Bethlehem Steel Company by R. S. Sage and F. R. Grant, G-E Review, September, 1938.

Unified Drives Increase Rod Mill Production by F. R. Grant and G. L. Beaver, Steel, September 6, 1943.

Speed Transients of D-c Rolling Mill Motors by L. A. Umansky and T. M. Linville, Electrical Engineering, April, 1934.

Speed Regulation of the Main Roll Drives by L. A. Umansky, 1927 Proceedings of A. I. S. E.

D-c Power Supply for Steel Mill Application by W. B. Snyder and C. C. Herskind, 1938 Proceedings of A. I. S. E.

Determination of Motor Capacity for Main Roll Drives by H. A. Winne, 1932 Proceedings of A. I. S. E.

DISCUSSION

[PRESENTED BY

A. F. KENYON, Steel Mill Engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

A. F. Kenyon: Mr. Snyder's paper touches briefly on the adaptability of mercury arc rectifiers as the source of direct current power for rod and merchant-bar mill main drives, and some further comments may be in order. At a West Coast plant, there is now being installed an 18-14 in. merchant mill in which the direct current power for the fourteen main and edger drive motors will be supplied from a 2500 kw, 600 volt, rectifier.

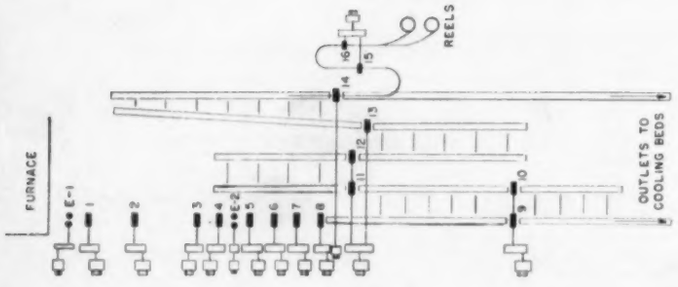
This mill is designed to be extremely flexible to enable rolling a wide variety of sections, ranging from large rounds, squares, flats, etc. delivered over runout tables to pilers or cooling beds; to small rods which are delivered to pouring reels and handled in coil form. The mill may be operated to deliver to outlets as follows:

1. Large bar and flat sections may be finished from stand No. 9. There is provided a flying shear immediately following stand No. 9, so that flats may be cut to length and piled at the end of the runout table.
2. Smaller sections may be finished from stand No. 12 or 14, and delivered onto cooling beds from the runout tables. The bar may progress either through all stands, or may be transferred from stand No. 8 to No. 11 without using stands No. 9 and 10. Heavier bar sections are handled from stand to stand by transfers, and lighter sections may be looped.
3. Small rod sections may be looped from stand No. 8 through stands No. 11 to 16 and delivered to the pouring reels, for further handling in coil form.

As has been stated by Mr. Snyder, and analyzed in detail in earlier papers presented before the Association, mills of this type offer one of the most attractive applications for mercury arc rectifiers, due to their reliability, operating economy, ability to carry high peak loads, and simplification of foundations and ventilation equipment; and do not impose unreasonable restrictions on the mill operation.

In the Kaiser installation, the motors will be started by voltage control, utilizing control of the ignition of the rectifier to bring the voltage up smoothly from zero to the normal operating voltage. Also during normal operation the bus voltage is maintained constant by a voltage regulator which functions by advancing or retarding the ignition. However it is not desirable to operate continuously under rolling load conditions, with reduced voltage obtained by ignition or grid control, due to distortion of the voltage wave with resultant poor power factor and greater danger of telephone interference, so the rectifier transformer is arranged with taps to provide normal operating voltages of about 420, 480, 540 or 600 volts, to permit operating the mill at slow speed on certain schedules. It is of course necessary to select the desired transformer tap before starting the mill. Emergency reverse operation of any motor at slow speed to back out a cobble is obtained by reversing the shunt field of the affected motor.

Another rectifier has been operating at a Cleveland district plant for nearly a year, this installation consisting of a 3000 kw, 600 volt, 12 phase, 25 cycle unit operating in conjunction with a 4000 kw, 60 cycle synchronous motor generator set, for the power supply to a group of direct current motors driving a narrow hot strip mill. The 25 cycle power available is generated from excess blast furnace gas, and is quite constant. A voltage regulator is arranged to maintain constant bus voltage by means of grid and ignition control of the rectifier, and a current regulator is arranged to maintain constant current output from the rectifier by controlling the excitation of the two 2000 kw generators. With this arrangement, the rectifier is made to operate continuously at some fixed power output, the value dependent upon the amount of 25 cycle power available, and adjustable by means of the current adjusting rheostat. When the power required by the mill motors is greater than the rectifier output, the difference is supplied by the motor generator set, and when the mill motors are lightly loaded or shut down, the motor generator set operates inverted to return power to the 60 cycle system.



Stand	Motor	
	Hp	Rpm
E-1	100	100/900
1	300	150/300
2	400	200/400
3	500	150/400
4	500	150/400
E-2	100	500/1250
5	600	300/600
6	600	300/600
7	700	300/750
8	700	300/750
9-10	1000	200/600
11-12-13	1425	235/660
14	500	125/375
15-16	500	300/750
Total	7925	

Cast Steel Roll

MANUFACTURE AND APPLICATION

. . . . no two mills are exactly alike in design, product, reductions and operator . . . . hence, roll application is not an exact science, but can be improved only by cooperation of the user and the manufacturer . . . . a knowledge of roll manufacturing methods will enable the user to obtain greater service and economy . . . .

by F. H. ALLISON, JR.

UNITED ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

▲ THE purpose of this article is not to teach the art of steel roll making. Those who are engaged in the manufacture of steel rolls well understand that such a purpose could not be achieved in one short paper. On the other hand, if the user of rolls becomes better acquainted with the methods by which a steel roll is made, it is likely that he can make better use of the rolls, will not be so apt to misapply them, and, through a better understanding of their limitations and advantages, get better life and service from them.

The usual method of casting a steel roll is shown in Figure 1. This shows the position of the mold in a roll flask with the outline of the finished roll super-imposed for comparison. The sand mold consists of five distinct parts: wabbler, drag neck, body, cope neck, and head.

The driving wabbler is usually cast at the bottom for two reasons. One is that the wabbler in this position can be cast close to size and thus minimize machining costs. But the chief reason is that the denser and least segregated metal is found in this portion of the roll, and hence the strongest metal is provided to resist the driving torque.

In order that the cast roll will be sound and solid, the mold must be designed to conform to the natural laws of freezing metal. This means that the mold design must allow the bottom portions to solidify first so liquid metal is always available from above to feed the shrinkage which occurs on freezing. Thus, the drag neck can be cast fairly close to the finished diameter. On the other hand, the mold diameter of the cope neck must usually be enlarged so as to feed liquid metal from the head to the body as long as the body remains molten. Since the metal of the cope neck is usually among the last to freeze and is hence somewhat more segregated, and since a considerable amount of the dense surface metal of the cope neck is removed in turning to finished size, it is usually not as strong as the drag neck. Designers should always take advantage of this fact and wherever possible use the drag neck for driving.

In the body portions of the roll mold there are embedded metallic chills which serve two purposes. Their primary purpose is to freeze the body surface quickly and thus condense the working layers of metal, giving the roll better wearing qualities. This same quick freezing of the body allows it to solidify faster than the cope neck, and hence the diameter of the cope neck does not have to be so large in order to provide molten metal from the head. This again reduces machining

Presented before A. I. S. E. Annual Rolling Mill Conference, Pittsburgh, Pa., May 8, 1944

time in finishing the roll and also provides better metal in the cope neck.

The only purpose of the head is to provide a reservoir of liquid metal for feeding metal into the roll as the natural shrinkage takes place during freezing. After the entire roll has solidified, the head contains a deep V-shaped shrinkage cavity.

The tabulation at the right of Figure 1 shows that the head accounts for a large amount of the cast metal weight, being approximately one-third of the melt. The turnings which are taken from the necks and body account for about one-sixth of the cast weight, so that the yield in cast rolls can be considered as roughly 50 per cent. From the standpoint of the finished roll that goes to the user, one may say that the head weighs $\frac{2}{3}$ and the turnings $\frac{1}{3}$ of the finished roll weight.

The gating of a casting, as every foundryman knows, is of considerable importance. As shown in Figure 1, steel rolls are gated at the bottom, and the illustration indicates that the metal is introduced on a tangent. This tangential direction imparts a fast circular or swirling motion to the molten metal as it fills up the mold. This swirl sets up a centrifugal force which

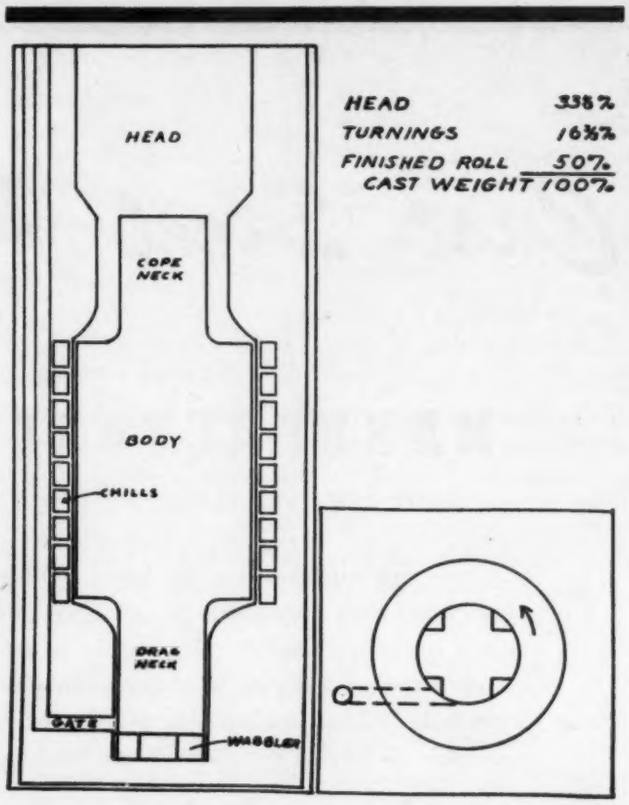


Figure 1 — Sketch showing usual method of casting a steel roll. Tabulation shows approximate yield from the rough casting.

causes the heaviest material to go to the outside, and conversely the lighter material goes toward the center. Thus sand, slag, and dross which are lighter than steel are swept toward the center of the roll during the pour, and the surface layers are formed of the cleanest metal.

The molds are made in two halves as shown in Figure 2 and after drying are closed together before pouring. The illustration shows the chills in place before covering them with sand. The center transverse bar, which is subsequently detached, is a support for a sweep, as are the semicircular bearings at each end. A sweep can be seen in position in another half mold in the background. When the sweep is rotated in the sand, the circular roll cavity is made, thus eliminating any necessity for a solid wooden pattern. In the designing of these sweeps, careful planning is required to provide for the shrinkage and contraction of the metal.

The roll maker is obliged to keep a considerable inventory of equipment on hand to make the numerous sizes and shapes of rolls required by the industry. This includes a large number of different sizes of flasks and chills. Chills can seldom be used more than three times due to their getting out of shape by the intense heat to which they are subjected, and frequently they are used only once.

A general picture of a steel roll molding floor is shown in Figure 3, with the molds of several rolls almost finished. The finished rolls will be carried to ovens where they will be dried thoroughly before being taken to the foundry dry-floor, where the two halves will be closed for casting.

Almost all the metal for cast steel rolls in this country is melted in open hearth furnaces. Only high quality

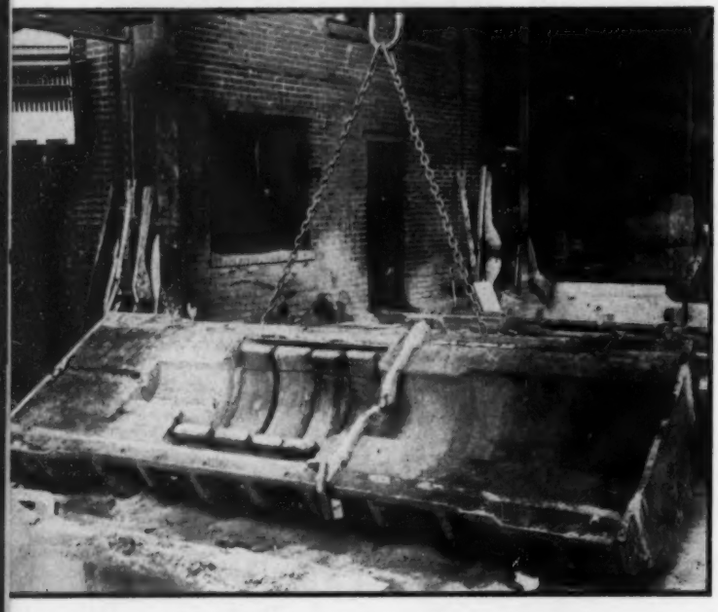


Figure 2 — This view of a half mold shows the chills in place before they are covered with sand.

▲

Figure 3 — General view of a steel roll molding floor, showing several molds almost finished.

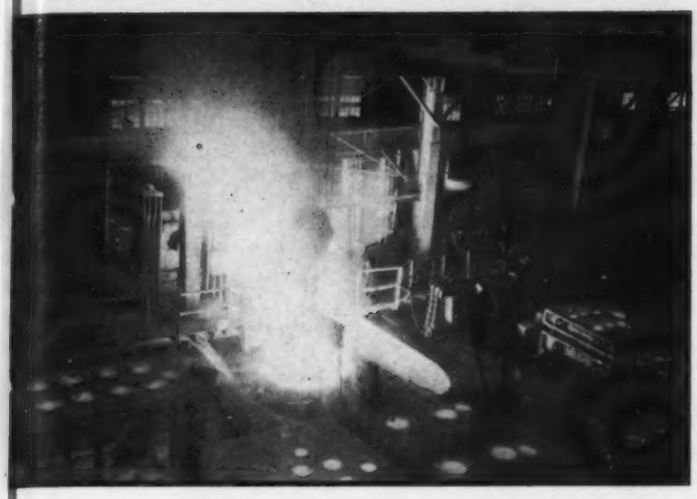


Figure 4 — When the metal reaches the desired analysis, it is tapped from the furnace into a ladle ready for pouring.

scrap and pig iron containing low phosphorous and sulphur can be used in the acid furnaces, since neither of these elements is eliminated in the acid process. Roll furnaces are generally of intermediate capacity. In the writer's plant a furnace will produce melts from 20 to 40 tons, thus making 10 to 20 tons of rolls. If a roll weighing more than 20 tons is desired, heats are melted in two or more furnaces and poured into the mold simultaneously. For a given composition or heat it is thus not possible to melt less metal than the equivalent of 10 tons of rolls. If this amount of orders is not on the books, the casting of rolls must be held up until sufficient tonnage accumulates. Thus special heats or analyses may cause delays in delivery, and it is therefore advantageous for the roll user to design rolls so that the more usual grades are required.

A number of tests are made on the open hearth during the melt to control quality, such as the carbon test taken during the working of the heat. A magnetic method of analysis provides for rapid carbon determination. By this method, carbon can be determined in 3 minutes as compared to 15 or 20 minutes by the usual laboratory combustion method. This speedier method allows better control of the quality of the steel melt, and is almost indispensable when melting double heats for the same roll. A test for the type of slag formed during melting is made with the fluidimeter. A spoonful of the molten slag taken from the furnace is poured quickly into the mold and the length of run is measured as an index of the slag fluidity. Based on this, adjustments can then be made to the metal or slag. When the metal in the furnace has reached the desired analysis and condition in the furnace it is tapped out into a large ladle as shown in Figure 4, while the melter and metallurgists look on. The temperature of the stream is taken with an optical pyrometer. This is necessary so as to control the correct pouring temperature of the rolls.

Figure 5 shows the pouring of a number of small rolls, the bottom pour ladle being transported from flask to flask as the molds are filled up. The temperature of the pouring stream is carefully checked during this operation. The pouring of a large roll may require two heats as shown in Figure 6. Liquid steel is flowing into the mold from both the near and far gates, while the foundryman peers down into the mold to inspect the swirling action.

After casting, it is necessary to allow the rolls to remain in the mold to solidify and cool. In larger rolls this may require a period of as much as ten days. When the roll is sufficiently cool it is shaken out, and the sand and chills are removed on the cleaning floor before the roll goes to be rough turned.

In rough turning, the body is roughed off, the excess stock is removed from the cope neck, and the head is cut off. The rolls are heat treated before final machining. In the background of Figure 7 two rolls are being rough turned on old type roll lathes, while the roll in the fore-

Figure 5 — This pouring operation is very similar to that for steel ingots, the bottom pour ladle being moved from flask to flask.

▲

Figure 6 — For large rolls, two heats of steel may be required, which are poured simultaneously into the mould.

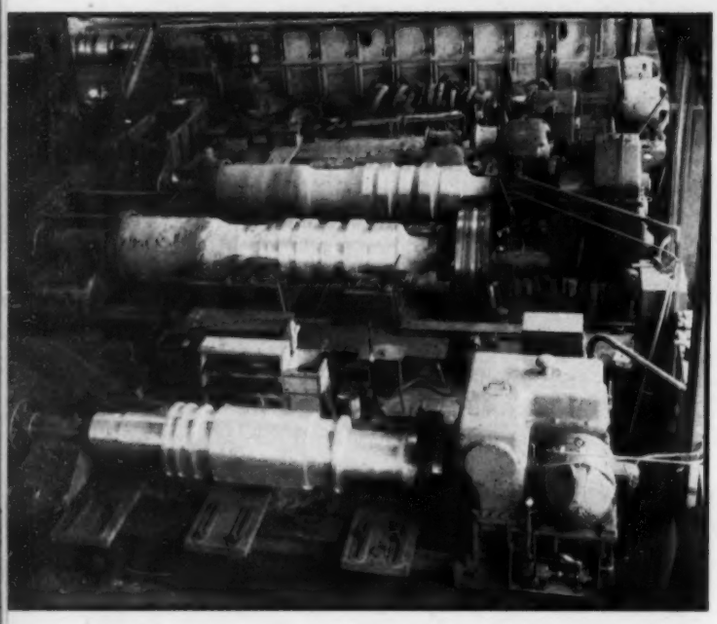


Figure 7 — The two rolls in the background are being rough turned while the one in the foreground is receiving a finish machining. Heat treatment is usual between the two machining operations. (top)

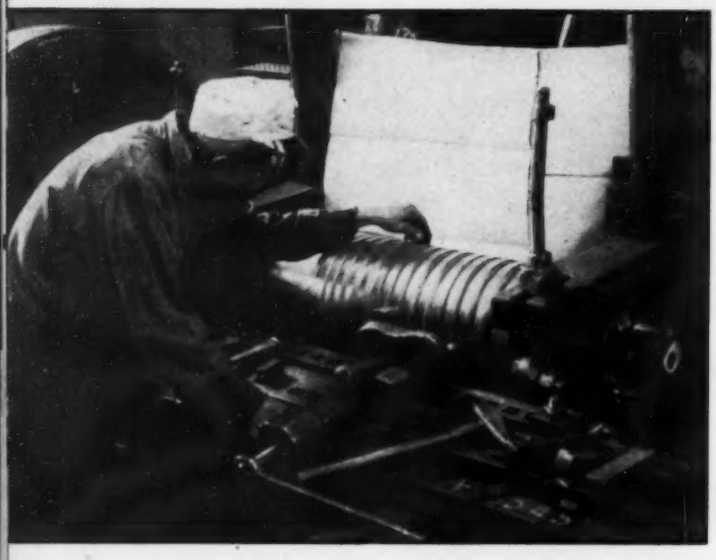


Figure 8 — Checking the passes with a templet while finishing a small shape roll. (center)

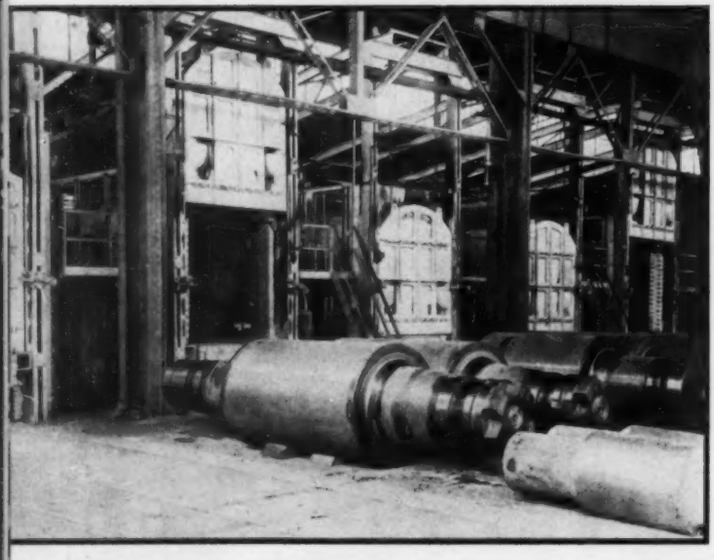


Figure 9 — Car type gas-fired annealing furnaces provide facilities for the heat treatment of rolls. Some heat treating cycles run as long as 21 days. (bottom)

ground is being finish turned on a new cone type gear roll lathe. The finish turning of a small shape roll is shown in Figure 8, in which the roll turner is checking the accuracy of the passes with a templet.

In order to develop full strength, steel rolls must be heat treated. A battery of car type gas-fired annealing furnaces for this purpose is shown in Figure 9. Sometimes heat treatment cycles as long as twenty-one days are required on certain rolls to develop their maximum properties. The type of heat treatment required depends upon the composition of the roll and the use to which it will be put.

After heat treating, the rolls are ready for finish turning to exact size and for any other accurate machine work that may be necessary on them. This usually includes finish machining of the drag wabbler, machining of a wabbler on the cope end, and a variety of other machine work such as cutting in locker holes, key slots, etc.

Grinding is usually the final operation on steel rolls. The close tolerances required in modern rolling practice demands somewhat greater accuracy than can be readily obtained with lathe tools. The roll grinder rapidly finishes the roll to tolerances of a thousandth of an inch.

Before shipping, rolls are carefully checked for surface quality, dimensions and hardness. Figure 10 shows a hardness test being made with a sclerescope on a backing-up roll. After inspection, the rolls are packed, crated, and ready for shipment to the roll user. This completes the manufacturing phase of cast steel rolls.

Steel rolls are made in an infinite variety of sizes and shapes. The smallest one made in the writer's shop is a pipe lap roll 6⅛ in. diameter by 6½ in. long weighing 60 pounds, while the largest roll is a 50 in. diameter x 204 in. long plate mill backing-up roll, weighing 77 tons.

As far as the application of rolls is concerned, a cast steel roll might be looked upon almost as a special type of iron roll. The main job of any roll is to resist the abrasive and deformation forces of the bar which is being rolled. For this purpose, the high carbon content of the iron roll is excellent, but it has the one serious disadvantage of being low in strength. The strength of a roll is materially increased as the carbon content is reduced, but the resistance to wear becomes less. Thus, in general, the best roll composition for any particular mill will be that of the highest carbon content which can be consistently used without breakage.

The effect of increasing the carbon on the mechanical properties of a typical alloy roll steel is shown in Figure 11. By increasing the carbon content from .50 per cent to 2.25 per cent, the transverse strength is reduced almost 50 per cent. The shock resistance, as shown by the impact tests, over the same carbon range

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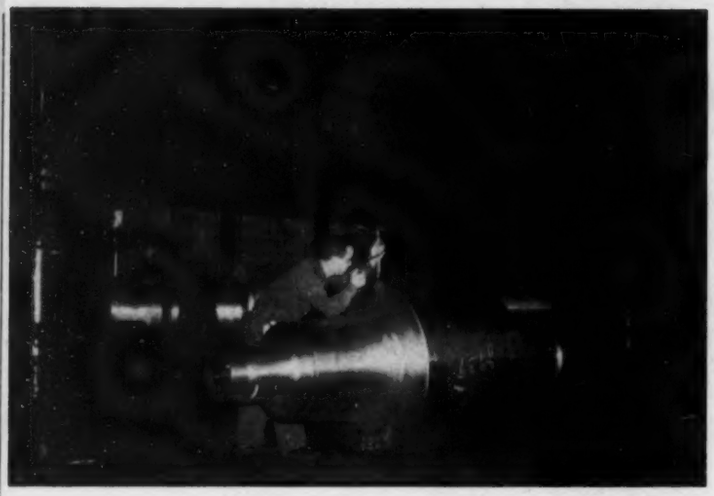


Figure 10 — Roll hardness is checked with a scleroscope as part of final inspection before shipping. (above)

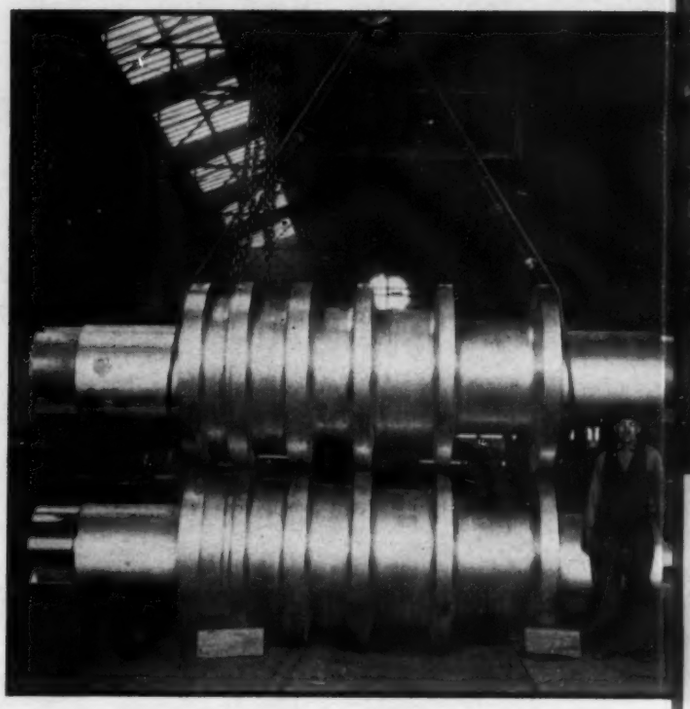
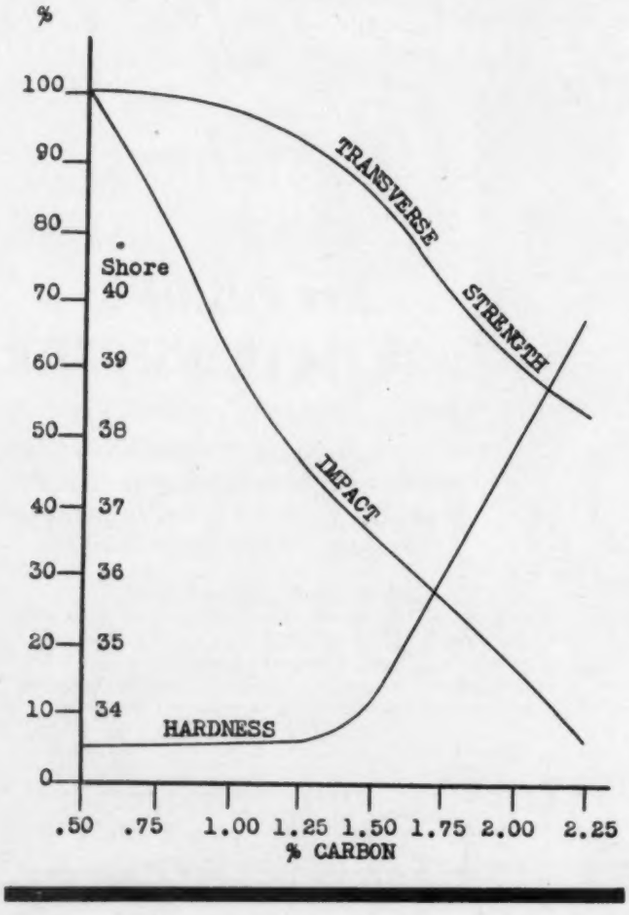


Figure 11 — Curves showing effect of carbon content on transverse and impact strength and hardness of an annealed steel roll containing 1 per cent Cr and 5 per cent Mo. (above right)

Figure 12 — These rolls for a three-high blooming mill require a strong material (not too high in carbon) because of the deep passes cut into them. (below)



is reduced markedly at 2.25 per cent carbon to about 1/20 of the value of .50 per cent carbon.

It is interesting to note that the hardness in this series of tests was not affected by increasing the carbon content from .50 to 1.25 per cent. Above 1.25 per cent carbon, however, the excess carbide in the microstructure becomes effective in increasing the Shore value. This does not mean that the wear resistance of a .50 per cent carbon roll is equivalent to that of 1.25 per cent carbon. By suitable heat treatment it is possible to raise the hardness of the .50 per cent carbon roll up up to 44 Shore, but at this hardness it will quickly wash and wear on hot rolling, while the 2.25 per cent carbon roll at 40 Shore will outlast it many times.

Although carbon is perhaps the most effective element in steel rolls, alloying elements such as chromium, molybdenum, and nickel contribute to wear resistance and strength. To obtain the best results, the proper balancing of these elements is required and they are usually added in amounts of .50 to 1.50 per cent.

In particular applications, as a general rule, the carbon ranges might be given as follows:

a. Roughing rolls: low and medium carbon, .50-1.20 per cent C.
b. Intermediate rolls: medium and high carbon, 1.00-2.25 per cent C.
c. Finishing rolls: high carbon, 1.80-2.60 per cent C.

As an example, the three-high blooming mill rolls in Figure 12, even though they are not reversing, require considerable strength due to the deep passes. Carbon contents above .85 per cent would hardly be recommended for this type of roll. Two-high reversing blooming mill rolls usually have shallower sections and the carbon in an alloy roll for this application can usually be increased up to 1.20 per cent without loss of the necessary strength. Slabbing mill rolls perform much the same work as reversing blooming mill rolls, and the carbon content will vary from .50 to 1.20 per cent carbon depending upon the character of the mill and

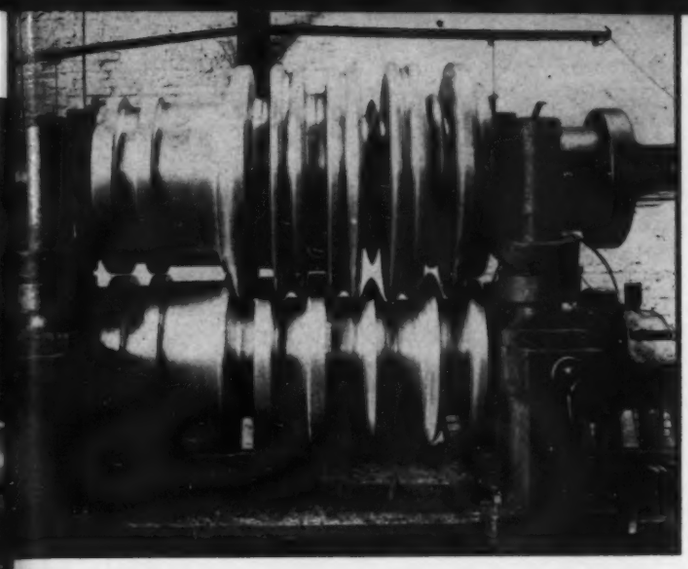


Figure 13 — Structural roughing rolls having deep grooves also require a rather high strength analysis.

drafts employed. Structural roughing rolls having deep sections as shown in Figure 13 require fairly high strength. The carbon content may range from .75 to 1.25 per cent in such rolls. Plate mill roughers, jobbing mill roughers, and muck mill rolls will be included in the lower carbon range from .50-1.00 per cent C.

The intermediate carbon range of 1.00-1.50 per cent C will include such rolls as roughers for billets and continuous billet mills, bar and continuous bar mills, and piercing mill rolls. Three-high sheet mill roughers are usually made in the range of 1.25-1.50 per cent carbon of special alloy content and treatment.

The higher ranges of carbon from 1.50-2.00 per cent C include merchant mill rolls, bar mill rolls, and structural intermediate rolls.

The highest range of carbon from 1.80-2.60 per cent C is used for finishing rolls, and is usually for special cases, for example, where an iron roll is too weak for the deep sections required, or where mill housing windows are too small to accommodate an iron roll of sufficiently large diameter.

Backing-up rolls must be regarded as a special type of roll. A backing-up roll does no reducing work in the same sense as those rolls which come in direct contact with the bar. It must resist pressure and spalling under rolling loads, and in a large measure its work is comparable to a roller in a roller bearing. The carbon content of backing-up rolls varies from .70 to 1.00 per cent and the alloy content and heat treatment is adjusted to the severity of the mill.

A general summary of roll applications is given in Table I.

In the foregoing discussion concerning roll applications it should be noted that only wide limits of chemical composition have been mentioned. This is due to the fact that no two mills are found to be exactly alike in product, reductions, design, or operator. For this reason, a particular grade of roll which will give maximum service in one mill, may not give the best results in another mill which appears to be the same type. Thus it is strongly urged that the mill operators keep complete records of the service life of the rolls and cooperate as fully as possible with the roll manufacturers in determining which grade and composition will give the maximum results. The roll makers have the background and experience which will usually suggest the type of roll best suited for a particular application, and their services are always available to help operators get the best rolled product at the lowest roll cost.

TABLE I

Cast Steel Roll Applications

Plain carbon — Where strength is not required. Low cost. Low carbons .50-.65 per cent for shock and ductility, high carbons up to .90 per cent for wear.

Alloy Steel

.50- .70% C — Blooming mill; roughing mills; for maximum ductility and shock resistance.

.70- .90% C — Blooming mill; jobbing mill roughers; sheet mill roughers; plate mill roughers and muck mills; backup rolls.

.90-1.10% C — Blooming mill; continuous bar mill roughers; backing-up rolls.

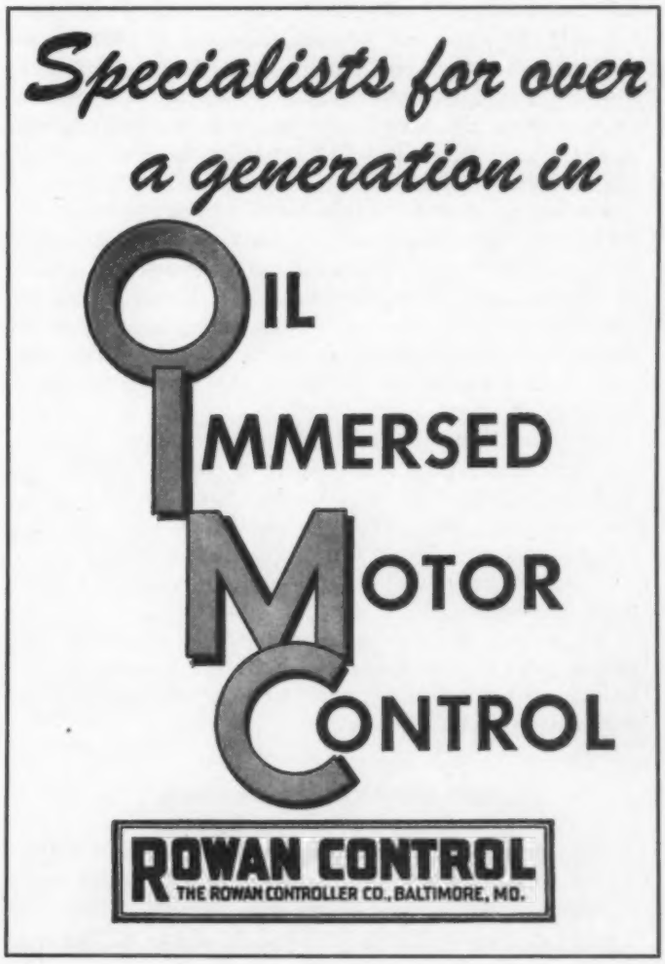
1.10-1.30% C — Blooming mills where breakage is not great; piercing mills; bar mill; billet mill; rail mill; structural mill roughers.

1.30-1.50% C — Rail mill intermediates; structural mill, continuous bar mill; continuous billet mill; 3-high sheet mill rolls.

1.50-1.80% C — Continuous bar and billet mill intermediate.

1.80-2.10% C — Rail and structural mill intermediates; all kinds of mills for finishing where housing design is too limited for iron rolls.

2.10-2.60% C — Finishing mill roll to meet unusual conditions.



Rolling Alloy Steels

AT ATLAS STEELS, LIMITED

. . . . cognizant of the fact that they cannot completely cover the field, the authors present an outline of some of the factors in the selection of a rolling unit to produce high alloy and special steels efficiently . . . . their viewpoint differs from that of the large producer of a limited number of grades . . . .

▲ WHEN selecting a cogging unit for a plant, present melting plus future or possible melting capacity must be established. It is then possible to consider other factors having a bearing on the size or type of rolling mill equipment to be purchased.

It is considered good sense to select a unit of sufficient capacity to care for normal expected expansion of business. Furthermore, this is the time when consideration and thought should be given to layout so that proper space allowance is made for the installation of such items as additional heating units, cranes, cooling equipment, conditioning and stock.

Rolling equipment should be made heavy enough to stand the abuse of periodic seven-day-per-week operation without undue maintenance or expensive repair shutdown time. This extra weight in design should be sufficient to take care of a reasonable percentage of unusual or unexpected changes in practice which the steel maker inevitably meets in this ever developing business.

Manufacturers of mill equipment have learned through experience that it is good policy to design a mill proportionately heavy. The manufacturer will, however, co-operate with a purchaser with limited capital and will lower initial cost by reducing shaft sizes, table girders and other items which help to reduce finished weight.

We believe the mill personnel can be helpful to the mill builder in smoothing out certain operating conditions pertinent and peculiar to products rolled in a particular plant.

TWO-HIGH OR THREE-HIGH

In a small plant where greater production makes mandatory the purchase of greater cogging capacity, the initial investment is the strongest factor in arriving at a decision between a 2-high blooming mill with reversing d-c drive, or a 3-high with constant speed a-c drive. The d-c drive costs considerably more to install. However, a 3-high constant speed mill requires larger rolls to handle the same size ingot than can be handled by the 2-high reversing mill. The 3-high mill has the further disadvantage of being less flexible. It is costly to maintain due to heavy lifting tables, and requires more roll changes to cover the range of billet and slab sizes.

In the selection of the unit, careful thought must be given to size requirements of blooms, billets or slabs for the finishing mills and forge departments, as well as the maximum size bloom that can be made from the largest ingot expected to be rolled. Close adherence to these requirements makes for greater efficiency and lower costs on these units.

Large rounds, squares and flats, in size ranges sufficient to cover the field, should be considered if opportunities are to be met in the field of potential business.

Forging billet requirements to outside customers is another important item to consider, since the customer's demands may cover a wide range of billet sizes.

To a plant with insufficient melting capacity to warrant a blooming mill and a large finishing mill, it seems advisable to combine and cover the range of business with one unit capable of taking care of the melting over the entire potential market of forging and finished bars.

26 IN. AND 22 IN. MILLS AT ATLAS

The Atlas management took stock of their needs, both existant and potential. After estimating the maximum tonnage expected, they found that:

Presented before A. I. S. E. Annual Rolling Mill Conference, Pittsburgh, Pa., May 8, 1944

by C. P. HAMMOND *and* *A. M. CAMERON*

SUPERINTENDENT OF MILLS ROLL DESIGNER

ATLAS STEELS, LTD.

WELLAND, ONTARIO, CANADA

1. Their business would consist of all grades of alloys plus tool and stainless steels.
2. Billets would be required for the finishing mills which would range in size, from 1¾ in. square to 6 in. square.
3. Blooms would be required for the forge shop up to 8 in. square.
4. Large rounds, up to 8 in. in diameter, and large flats would be required to complete the range of sizes.

From this information, the 26 in. 2-high blooming mill with a 3-high single stand 22 in. mill was decided upon.

SOAKING PITS

Due to the number of grades of steel requiring a long soaking period, it was decided to provide for 12 pits, each pit to hold one melting furnace heat of 30 tons. This would permit a heating cycle that would take care of almost any condition, including preheating of certain grades and repairs to pits. Nine pits were installed and used during the beginning of operations. When the melting capacity was increased, the balance of the plan was completed.

All steel for the 26 in. and 22 in. mills, and a portion of the steel for a 1000 ton press, is heated in twelve soaking pits. The pits are fired with hard coal producer gas. A single burner of 75,000 cu ft per hr capacity is placed high at one end of the pit. Return flue gases pass out of the pit from flues below the burner. Cold air is used for combustion. Pits measure 15 ft x 5 ft 6 in. x 9 ft.

Producer gas pressure is steadily maintained by means of an automatic controller at the pits. This device eliminates lag in gas supply and affords a steady 5 in. water column gas pressure to the pits. Automatic temperature control is provided on each pit by a potentiometer controller. Automatic combustion control is also provided for each pit. Adjustment of combustion is available to the soaking pit heater through a ratio dial on the panel board. Furnace pressure is maintained by an automatic regulator which controls the single pit damper.

No attempt is made to preheat air to the pits but waste gases from all pits pass into a single large flue and thence into a 400 hp waste heat boiler. Steam at 150 psi gauge pressure is injected into the mill steam system. The boiler is fully automatic and has auxiliary producer gas firing which is used if necessary. During normal pit operation, 5000 to 8000 lb of steam per hour is produced on this boiler. Since the main flue from pits to boiler is constructed of lightweight refractory, there is no perceptible drop in flue gas temperature on its way to the boiler fire box and little heat stored in the flue brick work.

Two stiff leg pit cranes, of two tons capacity, service the mill, pits and 1000 ton press. Ingots are delivered to the mill with an ingot chariot, making it possible for the crane to come straight out from each of the pits and place the ingot into the chariot which delivers it to the mill entry table. The ingot then passes through a gate to the mill table. The gate also acts as a deflector. As blooms get longer, the gate deflects the bars along the runback table. An ingot can always be delivered to the mill entry table without interfering with the ingot being worked in the mill.

THE 26 IN. MILL

The 26 in. mili is driven by a 1750 hp reversing motor, 60 to 150 rpm, connected to the pinion stand through a special gear type coupling. The motor is powered by two 750 kw 500 volt d-c generators, driven

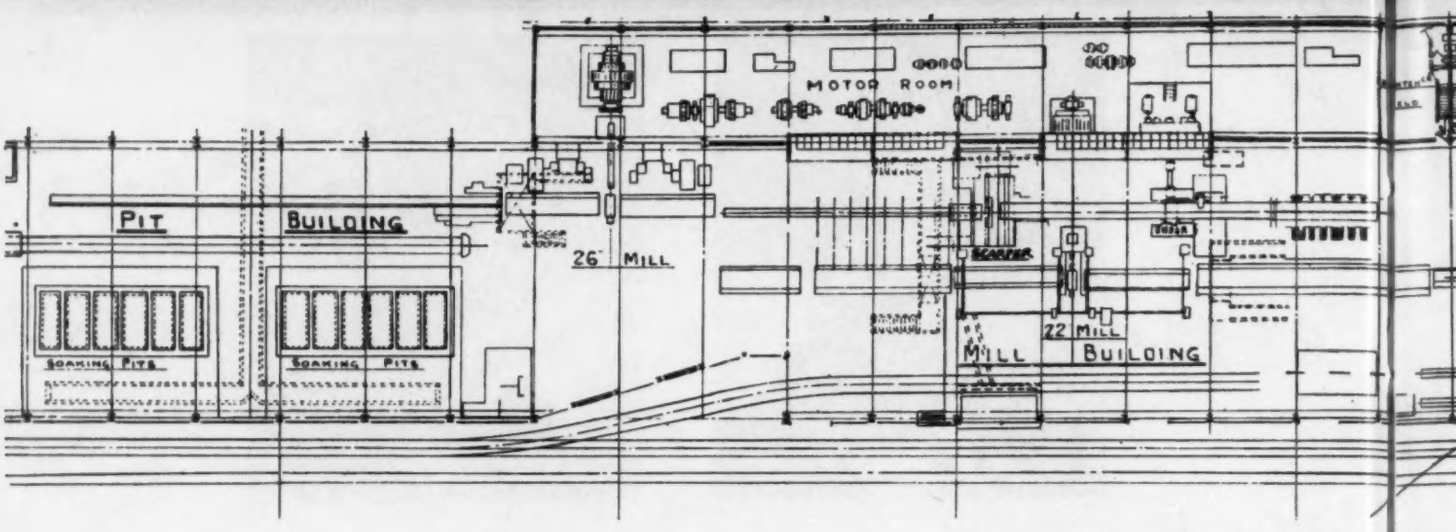


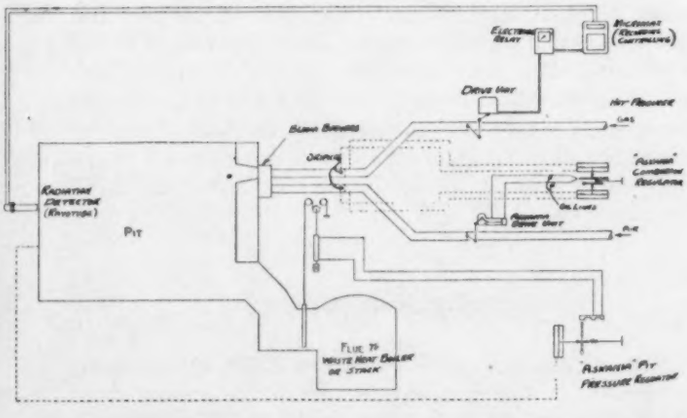
Figure 1 — Plan showing arrangement of 26 in.

by a 3200 kva synchronous motor, 500 rpm, 4150 volt, 3 phase, 25 cycle synchronous motor. To this motor is also connected a 500 kw, 250 volt d-c generator for cranes and auxiliaries.

Control is the conventional Ward-Leonard system and the operating mechanism is located in a pulpit immediately ahead of the 26 in. mill. Motor, generators and control switchboards are located in the motor room adjoining the mill. Load on the motor is controlled from a current regulator. When the motor is operating below base speed and a heavy load is encountered, its rate of acceleration is restricted. If the motor is operating at base speed, the speed is restricted on heavy load, and if the motor is operating above base speed, the field is strengthened and from this point the regulator tends to hold constant armature current. Thus, up to base speed the regulator will limit the current to a definite value and above base speed this value is reduced in proportion to actual motor speed.

The general mill assembly consists of a 2-high reversing mill stand, motorized screwdown, universal spindles, pinion stand, main motor, roll changing rig, electric manipulator, front and rear mill tables, ingot entry table, billet run-back table on the entry side, and a runout table to the shears.

Figure 2 — Sketch showing elevation of soaking pit and arrangement of controls.



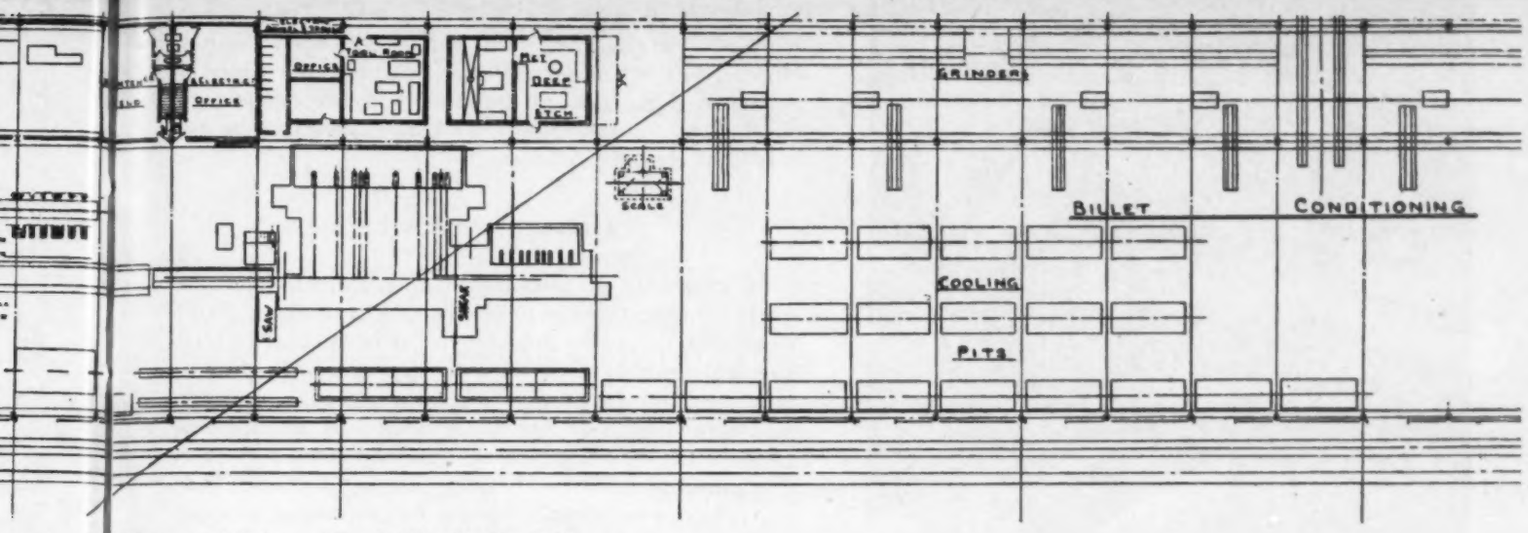
The mill housing windows are 33 in. wide by 8½ ft high. The two rolls are 27 in. in diameter and have an overall body length of 66 in. The roll necks, 16½ in. in diameter by 18½ in. long, are supported in three piece composition bearings with composition thrust collars, water and oil lubricated. The top roll is counterbalanced by weights located under the mill stand. An 18 in. bullhead is used and the maximum roll opening is 17½ in. Screws are 10½ in. in diameter with 1½ in. pitch. They are driven by two 50 hp mill type motors connected in parallel through herringbone and worm gearing set on top of the mill housing. The screw lift speed is 15 fpm.

The pinion stand has 26 in. pitch diameter by 36 in. face herringbone pinions, with babbitted bearings, all enclosed in an oil-tight case. Mill spindles are of the universal type, 12 in. in diameter and 11 ft 6 in. from centre to centre of couplings.

Feed rolls are an integral part of the mill housing and are individually driven by 9 hp motors. The rolls are 13 in. in diameter. The roll changing rig consists of a track assembled outside of the mill housings on which the two rolls and their chocks are pulled in and out by a cable arrangement attached to the overhead mill crane.

Manipulator side guards are 16 in. high and 19 ft 6 in. long, and the maximum opening is 57 in. The guards are driven by 50 hp motors connected in series through gear reduction drives and rack and pinions. The fingers are mounted in the left side guard on the entry side only. They are driven by two 25 hp motors connected in series through gear reduction drive and worm reducer. The speed equals 40 lifts per minute. Sideguard speed is 145 fpm.

Front and rear mill tables are 25 ft 8 in. long. They are driven by two 50 hp mill type motors connected in



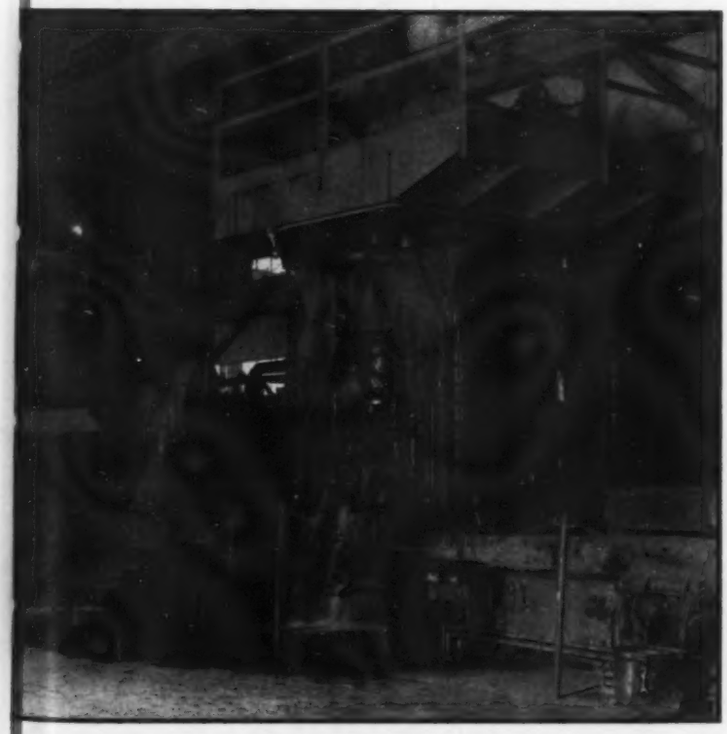
26 in. and 22 in. mills at Atlas Steels, Ltd.

series through gear reduction drive and bevel gears. The maximum table speed is 400 fpm. Rolls are 13 in. in diameter by 5 ft 7½ in. long spaced 22 in., centre to centre.

All table rolls are mounted in roller bearings. Preceding the mill table on the entry side is the ingot entry table driven by a 15 hp motor. This table is of similar construction to the mill tables with 13 in. diameter rolls of 47 in. body length. The table is 7 ft 4 in. long and has a speed of 370 fpm. Also preceding the mill table on the entry side is the billet runback table of 18 ft. 4 in. length. Rolls are 13 in. in diameter by 24 in. body length, spaced 44 in., centre to centre. A 25 hp motor drives the table at a maximum speed of 400 fpm.

On the delivery side of the mill, following the mill table, is 76 ft runout table to the 10 in. x 10 in. electrically operated mechanical shears. The table is divided into two parts, each operated by a 35 hp mill type motor which gives a table speed of 400 fpm. The rolls are 13 in. in diameter by 30 in. body length with 4 ft spacing at the start and 2 ft 6 in. spacing as it approaches the shears and finally 18 in. spacing near the shears. The product from the mill can be delivered through the shears and kicked off into holding cradles or run back from the shears and transferred by a 65 ft transfer table to the feed line of the 22 in. mill, approximately 25 ft away.

Figure 3 — View of 26 in. mill showing operators in pulpit on two different levels.



A centralized greasing system is used on the mill stand, the manipulators and the table bearings. A centralized oiling system services the pinion stand, manipulator drives and other parts of the system. A separate circulating oiling system located on and under the top platform of the mill housing lubricating the screwdown mechanism.

The 26 in. mill pulpit is placed 25 feet from the mill on the entry side. Connected to this is a catwalk leading to the mill housing platform, permitting quick access for making any adjustments on top of the mill proper. The two operators, at different elevations, are seated one directly in back of the other on the centre line of the mill. Each has clear vision for alignment of bloom to the roll pass when entering the mill. The controls are modern and sensitive, which facilitates speed in operating.

After the ingot is worked to a billet suitable for the section required on the 22 in. mill, it is run down to the shear in the 26 in. mill line, the hot top is cut off and the billet transferred across to the 3-high 22 in. mill line. At the present time, a hot scarfing machine is being installed ahead of the shears. The billet will then be skinned on the way to the shears before cutting off the hot top.

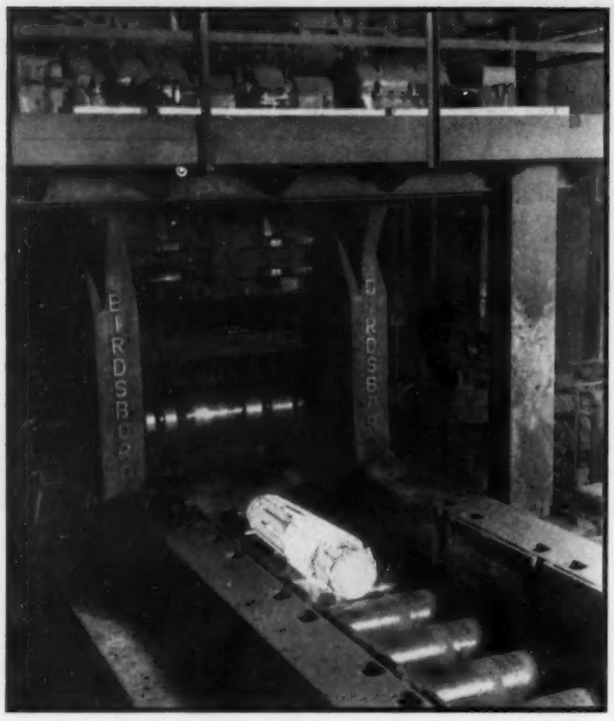


Figure 4 — Another view of the 26 in. mill from the discharge side, showing an ingot which has just received the first light pass.

THE 22 IN. MILL

The 22 in. 3-high mill is operated by a 1250 hp reversing d-c mill motor, 50 to 100 rpm. The motor is powered by a 1000 kw, 600 volt, 750 rpm, d-c generator which is driven by 1450 hp, 4150 volt, 3 phase, 25 cycle synchronous motor.

This is also the conventional Ward-Leonard control and the motor and control switchboard are situated in the same motor room as the 26 in. mill drive.

The 22 in. mill is a conventional 3-high stand. The rolls are 66 in. long, neck 14 in. x 14 in., and the mill is equipped with tilting tables on each side of the mill. There is 130 feet of runback table on the entry side, and 150 feet of delivery table. Spare housings are kept built up to eliminate lost time for roll changing. The housing change requires 10 minutes. This lends to flexibility in rolling different sections, with a minimum of lost time for roll change. The steel can always be scheduled through the 26 in. mill line while a change of housing is being made on the 22 in. mill. The variable d-c drive is of great advantage, permitting low speeds on large sections and higher speeds on the small sections, which facilitates the division of the work between the two mills. It also assists when starting sections such as large rounds, preventing cold ends and the marking of rolls and in many instances eliminating loss of the bar at that point. Rounds, squares, flats and billets are finished on this mill. All blooms for finished bars and forging billets are heated in the soaking pits, reduced in the 26 in. mill to the section required to enter the first pass in the 22 in. mill.

In the 22 in. mill line is a 72 in. hot saw, 40 ft of cooling bed and a 7 in. shear equipped with kickoff table and cradles. Next in line is the slow-cooling equipment which consists of cradles in which are placed the hot blooms, billets or finished bars. An insulated cover is placed over the steel in the cradles. Temperatures are checked by thermocouples so that covers can be removed at the proper time.

BLOOMING PRACTICE

On all grades of high alloy steel, the ingot should be worked during the first passes with light drafts of about 7 per cent reduction until the ingot is squared to butt size. The number of passes will vary with ingot designs carrying a different taper. When the ingot is squared to butt size, the draft can be increased to as much as 20 per cent, depending on the grade of steel. However, it is sound practice to work the first ingot of each heat cautiously, even though there is no grade change, especially on a grade that is susceptible to tearing. In isolated cases, tearing can be eliminated or kept to a minimum by blooming to butt size and recharging into the pits. This method can be used to increase the yield when difficulty is encountered on any particular heat, with slight loss in production. The practice is called "saddening." This is good practice for any new or special

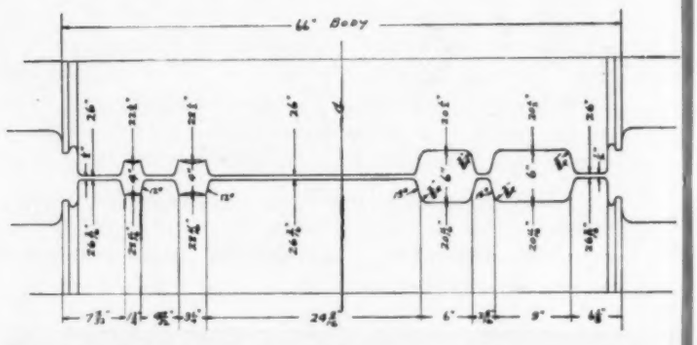
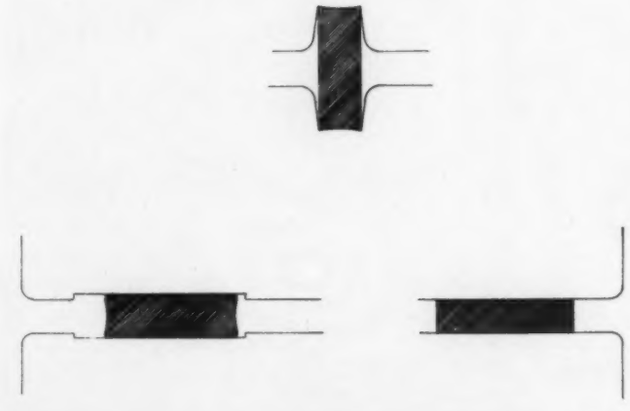


Figure 5 — Roll passes in the 26 in. 2-high mill for rolling flats.

▲

Figure 6 — Pass design in the 22 in. 3-high mill for rolling square edge flats.



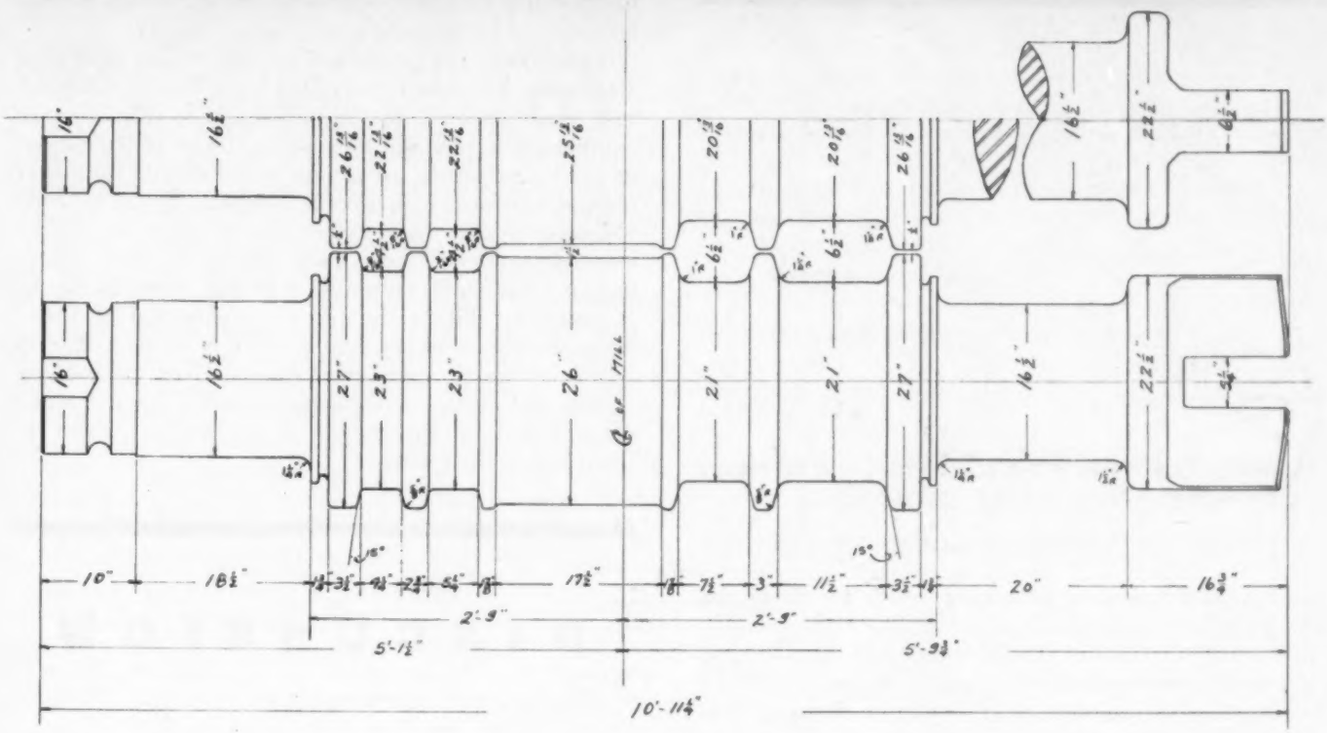


Figure 7 — Roll passes in the 26 in. 2-high mill for rolling 4 in. x 4 in. billets from 19 in. ingots.

grade when there is any doubt of the grade not rolling well.

Pass design for blooming is sometimes not given very much thought due to the fact that the bullhead will assist in getting what is required. Each mill usually finds its own necessary pass design to suit certain ingot and mill conditions. Depth of passes, radius and degree of ingot taper are all important factors, especially when a number of different grades have to be handled on the same rolls. Edging passes should be of reasonable depth to give more support across the corners and insure a square bloom. They also permit a more speedy operation, as the operator can work with less fear of the bloom climbing the collars. Grooves should not be crowded, even though no noticeable effect is evident on the bloom. If crowded, they will wear wide and more will have to be taken off the diameter of the roll to restore them to the original width when dressing. If wear is excessive, they can not be restored. Not more than two passes should be worked in an edging groove without slabbing on the bullhead. On these two passes, the work should be distributed so that the second pass through does not crowd the edging groove. Surface defects can be caused by too much edging reduction. To eliminate this, it is necessary to make alternate passes on the bullhead. The practice of running the rolls in the mill too long is also detrimental to surface conditions, especially on alloy grades.

EFFECTS OF HEATING AND ROLLING ON SURFACE

A number of experiments have been made in the processing of ingots with the view of arriving at the correct heating practice which would meet metallurgical requirements for the rolling and surfaces of billets and finished bars. The factors considered include time for bringing up to temperature, maximum temperature, soaking time and furnace atmosphere. The practice employed will vary with the grade being heated.

It has been considered desirable to bring the ingot to the mill with a fairly heavy scale which will come off easily. However, there is yet something to be learned on the nickel grades, which are not free scaling but whose scale tends to cling to the ingot while rolling. This scale is rolled into the ingot during reduction and forms pockets in the bloom which elongate and close up, causing surface defects.

Let us consider, for a moment, practice at the finishing mills which produces a desirable surface. Here the pitted surface condition is eliminated on the finished bar by heating the billets to rolling temperature with a minimum of scale. By removing this scale completely during the early passes, the finished section is free of the light mechanical seams caused by rolling in scale. It would, therefore, seem logical to assume that whatever seams may be attributed to rolled-in scale at the blooming mill would be minimized by forming only light scale on the ingot, particularly on the nickel grades. It is improbable that badly pitted ingot surfaces can be completely or satisfactorily cleaned by excessive scaling of the ingot.

Several methods of descaling are used on the finishing mill. Flat and edge on the first two passes after the billet is ejected from the furnace is common practice. Scale boxes were one of the first methods tried, usually used on hand rounds, placing the open end box filled with scale so that the bar ran through the scale on each

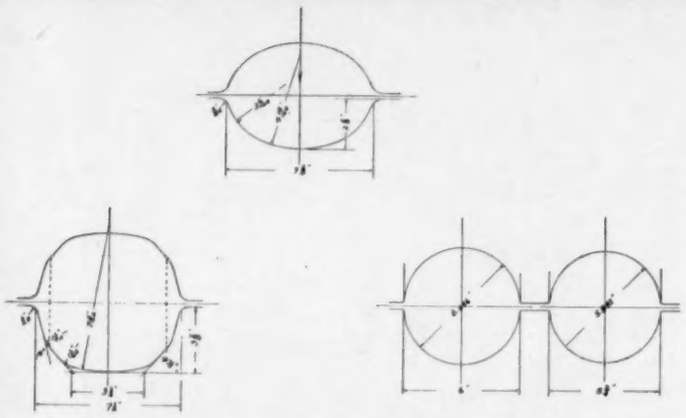
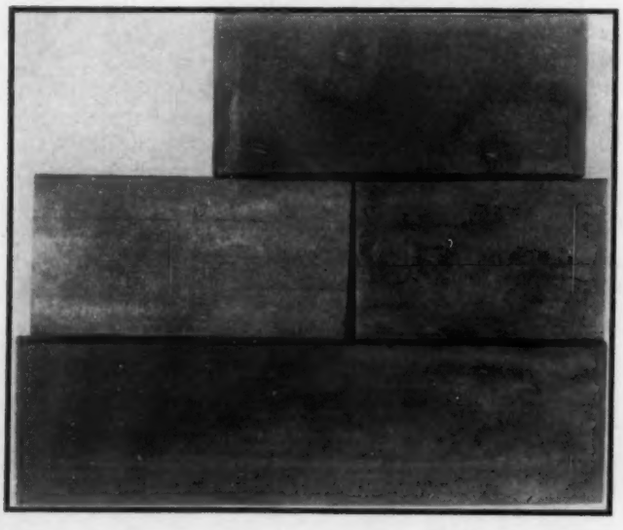


Figure 8 — Pass design in the 22 in. 3-high mill for rolling guide rounds.

pass. Wire brushes on all edging passes are beneficial. High pressure water produces more satisfactory results. However, the pressure should be not less than 800 psi. If possible, the scale formed in the furnace should be removed before any passes are made in the mill. This will eliminate the pockets of scale formed in the marks left by conditioning. A better finished bar surface will be obtained.

Excessively worn rolls will cause an undesirable finished surface. A worn flat pass used ahead of an edging pass will cause wrinkles. A worn reduction oval leading into a square will also cause wrinkles on the open corners which will be more pronounced if the square is slightly underfilled. When the open corners come in contact with the next pass, light seams are formed. It is not difficult to determine the origin of these defects as they are shallow and are usually from $\frac{1}{8}$ in. to $\frac{1}{2}$ in. in length. The rest of the bar surface will appear rough and if etched will have the appearance of being sandblasted with coarse sand. On stainless steel the effects of a rough pass will appear on the finished bar as small minute slivers which can readily be detected by rubbing a cloth along the bar.

Figure 9 — Examples of seams believed to be caused by rolled-in scale (1½ in. squares, .80 per cent C, pickled).



The mills in the future will be expected to meet high standards on finished, hot rolled bars. This will necessitate improvements on the mill, on the mill accessory equipment and on mill techniques. Items of equipment in use today, which are giving better results than ever obtained before, will become obsolete. Improvements will come as they have before. The mill and machinery manufacturers will keep pace. Given the best equipment, rolling mill personnel will still have to be resourceful to obtain the product demanded of them. They must look to the future and day by day develop better methods to get better results. Even the mill designers and plant engineers will be called upon to make changes and improvements in equipment which to them has seemed perfect.

DISCUSSION

PRESENTED BY

R. H. WRIGHT, Steel Mill Engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

H. G. R. BENNETT, Engineer Hot Rolling Mills, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania.

ROSS E. BEYNON, Superintendent Roll Shop, Carnegie-Illinois Steel Corporation, Chicago, Illinois.

LOUIS MOSES, Superintendent Rail Mill and Roll Department, Bethlehem Steel Company, Sparrows Point, Maryland.

C. P. HAMMOND, Superintendent of Mills, Atlas Steels Limited, Welland, Ontario, Canada.

R. H. Wright: The authors of this paper have given an excellent analysis of the problem of selecting equipment for rolling moderate quantities of special steels. Previous to the installation of the 26 in. blooming mill, cogging work at the Atlas plant had been done in a small 3-high mill. Because of the lower overall first cost, the use of a 3-high mill may sometimes appear attractive for a new installation. However, the operating advantages of a 2-high mill usually will easily outweigh any difference in first cost, even for small sizes. Anyone who sees the Atlas mill for the first time immediately gets the impression that a 2-high bloomer does not necessarily need to be large and expensive. Further inspection shows that it is not necessary to sacrifice any desired operating features in designing a small mill. The complete installation is a fine example of balanced and economical design.

The 1250 hp reversing-type drive for the 22 in. 3-high mill replaces a constant speed geared drive with flywheels. The change was made in order to have more power available and to secure the advantages of adjustable speed operation as outlined by the authors.

Direct current power for both mills comes from synchronous motor-generators. Where the power system will permit the use of synchronous motor generators is very satisfactory for small capacity drives and gives the minimum equipment cost.

H. G. R. Bennett: If the 2-high mill produces the bloom that is desirable, why didn't they go a little further and make the secondary mill of the same type?

Ross E. Beynon (Carnegie-Illinois Steel Corp.): What are the ingot size and weights that are rolled on the 26 in. mill? Also, what are the ranges of products finished on the 26 in. mill, and also on the 22 in. mill?

Louis Moses: This paper is another contribution to the literature being assembled on rolling mills. It outlines the various considerations to be given to the building of a new plant and clearly describes the equipment selected to meet the objectives in mind.

I think that particular note is to be made of the author's recommendations on rolling and heating practice, roll maintenance and scale removal as aimed toward the production of quality steels.

What is the difference in the power for a given reduction of alloy steel at rolling temperatures as compared to that for the ordinary carbon grades?

R. H. Wright: It is rather risky to make any general statements regarding the relative power requirements for rolling alloy ingots and low carbon ingots. This is, of course, because there are many alloys, requiring a considerable range of rolling temperatures.

If all alloys could be heated to 2200 F, the power required in the blooming mill would not be much greater than for low carbon steel. In general, alloy steels will require about 25 per cent more power because they must be rolled at lower temperatures. The soaking temperature of low carbon ingots can vary 100 degrees or more without much effect on the rolling power. On the other hand 100 degrees lower soaking temperature has a marked effect on the power required for rolling high carbon and alloy steels.

C. P. Hammond: The first question, in regard to why the 22 in. mill was made 3-high, may be answered by stating that it was mainly on account of the initial cost. However, with the amount of ingot capacity or melting capacity and the amount of total rolling capacity, we planned at that time, that we would have sufficient rolling capacity to take care of our total melting capacity. Since the 22 in. mill drive has been changed to the reversing 1250 d-c motor we have used this unit as a reversing mill on certain billet sizes, which gave a better delivery than we were getting on 3-high operation.

However, with the 3-high, for instance when rolling rounds, using the top and the middle rolls as the oval and the bottom and middle as the finishing, we do have some adjustment with the oval. With a screw-down top and bottom you get the same thing but, as you are always moving them up and down, I don't believe it is quite as accurate as the way we have it.

Our regular ingot is a 19 in. round corrugated ingot weighing 4600 pounds. We use 16 in. ingots on most of our stainless grades and on our high carbon grades. We use a 22 in. ingot for large sections, such as square blooms that are to be shipped out in the bloom form 7½-8 in. square. All of the ingots above are round corrugated.

As to range of sizes from the 22 in. mill, we make rounds from 3 in. to 8 in. and billets from 1¾ in. to 5 in. square. The larger billet sizes come from the bloomer. We do not have a large range of slab sizes, since we do not have a sheet mill or plate mill, but we do make a certain amount of slabs. We can make up to 18 in. wide and down to 1½ in. thick.

In regards to flats, we have a layout to cover 4 in. x 1¼ in. to 10 in. x 1 to 2 in. thick. We are making such sizes as 3½ in. by 2⅛ in. and 4⅝ in. by 1⅛ in. These sizes require a special set up.

We also have a line-up for sharp corner squares to meet requirements of customers.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC. OF

IRON AND STEEL ENGINEER

(Required by the Acts of Congress of August 24, 1912, and March 3, 1933)

Name of Publication: *Iron and Steel Engineer*, published monthly at Pittsburgh, Pennsylvania. (Report of October 1, 1944.)

State of Pennsylvania

County of Allegheny

Before me, a notary public in and for the State and county aforesaid, personally appeared Brent Wiley, who, having been duly sworn according to law, deposes and says that he is the editor of the Iron and Steel Engineer and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher: Association of Iron and Steel Engineers, 1010 Empire Building, Pittsburgh, Pennsylvania.

Editor: Brent Wiley, 1010 Empire Building, Pittsburgh, Pennsylvania.

Managing Editor: None.

Business Manager: T. J. Ess, 1010 Empire Building, Pittsburgh, Pennsylvania.

2. That the owner is: Association of Iron and Steel Engineers, 1010 Empire Building, Pittsburgh, Pennsylvania.

No stockholders.

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1944

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BRENT WILEY, Editor.

Sworn to and subscribed before me this 20th day of September, 1944.

G. WILLIAM JONES, JR., Notary Public.

(My commission expires February 9, 1947.)

EMERGENCY LOADING OF

Electrical Equipment

. . . . full loading will get the most out of equipment with a minimum use of material . . . . temperature limits of insulation alone are not necessarily the measurement of loading . . . . mechanical parts, slip rings, brush capacity, cable connections, etc., may be limiting factors . . . .

by FRASER JEFFREY

ASSISTANT TO CHIEF ENGINEER

ALLIS-CHALMERS MANUFACTURING CO.

CHICAGO, ILLINOIS

▲ THE American Institute of Electrical Engineers and the American Standards Association have set up standards for temperature ratings of different types of rotating electrical equipment. These standards are for the protection of these various types of machines and it is generally presumed that these standards define safe limits for operation. Actually, the standards only define a measure of a machine under fixed and definite conditions. This means that a rating becomes arbitrary in the sense that it must necessarily be established by fixed standards and cannot therefore indicate the safe operating limits under all conditions that occur in actual service.

The usual temperature ratings agreed upon by user and manufacturer are in general lower than the standards provide. The purpose of this discussion is to show how a comparison of the usual temperature ratings with those provided by the standards may point out possibilities of securing greater emergency output while keeping within the temperature limits set by the standards. The effect that this increased output might have on the life of the equipment will also be shown.

While the basis of this discussion depends on increasing temperatures, other important items enter the problem besides temperature. Temperature is not the one limiting condition when considering overloading. It will be shown later that other limitations may exist, electrical or mechanical, which may be even more important.

Because of the war, industry has been and is even now faced with serious shortages of so-called critical materials such as copper, steel, tin, magnesium, mica, etc., all of which are used extensively in the fabrication of electrical equipment. Therefore, by due and serious consideration given to the matter of overloading equipment already installed, tremendous savings in these critical materials might be effected.

For some years, the manufacturers of electrical equipment have, through necessity caused by the scarcity of these critical materials, been doing everything possible to conserve them. By redesign, even new tooling, very substantial savings in copper and steel have been effected. By substitution of other materials for copper in various bronzes, by the substitution of other materials for tin in babbitt and solder, by the new technique of brazing joints with silver solders, by the elimination of magnesium in resistance materials, by research, tests, and countless other means, further far reaching economies have been attained.

On the other hand, it has only been within quite recent times that the operators of electrical equipment have been giving serious consideration to this most important subject. This is due possibly to the fact that up to the present time there has been very little published data pertaining to this subject.

The War Production Board in the early part of December, 1942 issued their general conservation order

Presented before A. I. S. E. Chicago District Section Meeting, May 2, 1944

L-221, restricting ratings of motors and generators with respect to determined loads, etc. The A. I. E. E. at the mid-winter technical meetings in New York the latter part of January, 1943 brought out their committee report which in many ways was similar to that of the War Production Board general conservation order. In the latter part of June, 1943 the A. I. E. E. brought out their Interim Committee Report on the loading of generator equipment. Neither one of the A. I. E. E. reports has been released for general publication.

APPROACH TO SUBJECT

The approach to the subject may be likened somewhat to the life of a man. Life insurance actuary figures allocate, on an average basis, the number of years which any given man is supposed to live. Some of these men may live for considerably longer periods of time, while others may pass out of the picture before the time allotted to their life span.

If a man who has lived a normal life is suddenly confronted by an emergency condition brought about by war, where his pace of living and pace of working is greatly accelerated, the life span of that man, neglecting hereditary trends, will likely be decreased, probably in some direct proportion to the rate at which he accelerates his living and working conditions.

The same thing holds true with electrical apparatus, where, just like the man under normal operating conditions, a certain length of life is expected, the life of the equipment will also be shortened under accelerated load conditions in a very definite ratio to the amount of the extra loading imposed.

There is, however, one great difference between the man and the electrical equipment that must not be overlooked. The man can accelerate his working capacity to any limit which he can physically stand while the electrical equipment must always limit its working capacity within the limits of all the interconnected electrical equipment and other power equipment associated with it.

For instance, a motor-driven centrifugal pump or air fan operating against constant head ordinarily cannot be made to deliver any greater volume of water or air with a correspondingly greater increase in the power required unless a different runner is used on the rotating member of the pump or fan.

However, a pump discharging water against a head that will be decreased by taking off increasing amounts of water, such as in an irrigation district, would run up the power required for this actual condition of operation.

A generator capable of considerable overload capacity may not be able to utilize such excess capacity due to limitations of overload on the machine driving the generator. A case in point would be a diesel engine. Ordinarily with this type of driving equipment, unless specially designed for it, a 10 or 15 per cent overload might be all that could be handled, and even then with possibly a very smokey exhaust.

On the other hand, steam turbines driving generators built for a given kva load at 80 per cent power factor, are sometimes capable of operating their driven machines at full kw, unity power factor load, or the equivalent of 25 per cent overload. However, the question might arise as to the capabilities of the boilers and the boiler auxiliary equipment, such as the forced and induced draft fans, boiler feed pumps, etc., to carry sustained overloads of this nature.

Switchgear is usually maximum rated and therefore cannot be subjected to overloading unless it were first installed of greater capacity than needed at that time.

TEMPERATURE STANDARDS

Consider first the limiting insulation temperatures and temperature rises as set up by the A. I. E. E., or the American Standards Association as specified for rotating electrical equipment such as induction motors, synchronous motors and generators, d-c machines, turbo-generators, etc.

From Table I it will be seen that the total limiting temperature according to the standards for class A insulation is 105 C; that for class B insulation is 130 C. These total limiting temperatures are made up by the addition of the ambient rise, and hot spot temperatures.

If a class A insulated machine is operating under load with an ambient temperature of 40 C, a rise of 50 C is allowed when temperature is measured by thermometer, corresponding to a limiting observable temperature of 90 C. If the temperature is measured by the embedded detector method, a rise of 60 C is allowed, corresponding to a limiting observable temperature of 100 C. Likewise, the rise of 70 C and 80 C with class B insulation corresponds to limiting temperatures of 110 C and 120 C.

The reason for these differences in observable limiting temperatures depending upon the method of

TABLE I

Standard Limiting Observable Temperatures and Temperature Rises

Method	Class A insulation					Class B insulation				
	Safe limiting observable temp A. S. A.	Rise A. S. A.	Ambient A. S. A.	Hot spot A. I. E. E.	Total limiting temp	Safe limiting observable temp A. S. A.	Rise A. S. A.	Ambient A. S. A.	Hot spot A. I. E. E.	Total limiting temp
Thermometer	90 C	50 C	40 C	15 C	105 C	110 C	70 C	40 C	20 C	130 C
Resistance	100 C	60 C	40 C	5 C	105 C	120 C	80 C	40 C	10 C	130 C
Embedded detector	100 C	60 C	40 C	5 C	105 C	120 C	80 C	40 C	10 C	130 C

TABLE II

Possibilities for Securing Increased Capacity from Induction Motors Above 200 hp.

Method	Usual temperature rises specified				Possible increased temperature rises that might be allowable				Possible increased total limiting temperatures			
	Class A insulation		Class B insulation		Class A insulation		Class B insulation		Class A insulation		Class B insulation	
	Stator	Rotor	Stator	Rotor	Stator	Rotor	Stator	Rotor	Stator	Rotor	Stator	Rotor
Thermometer	40 C	40 C	50 C	50 C	50 C	50 C	60 C	60 C	105 C	105 C	120 C	120 C
Resistance	50 C	50 C	60 C	60 C	60 C	60 C	70 C	70 C	105 C	105 C	120 C	120 C
Embedded detector	50 C	50 C	60 C	60 C	60 C	60 C	70 C	70 C	105 C	105 C	120 C	120 C

TABLE III

Guide for Selecting Hp Ratings of Alternating Current Continuous Rated 40 C Motors

If the hp load		Select
Exceeds	And does not exceed	A-c 40 C motor rated
.93	1.25	1 hp
1.25	1.87	1½ hp
1.87	2.5	2 hp
2.5	3.75	3 hp
3.75	6.25	5 hp
6.25	9.37	7½ hp
9.37	12.5	10 hp
12.5	18.8	15 hp
18.8	25.0	20 hp
25.0	31.2	25 hp
31.2	37.5	30 hp
37.5	50.0	40 hp
50.0	62.5	50 hp
62.5	75.0	60 hp
75.0	93.7	75 hp
93.7	125.0	100 hp
125.0	156.0	125 hp
156.0	187.0	150 hp
187.0	250.	200 hp

temperature measurement used is quite easily understood. If the temperature of the copper in the coils in the central and most inaccessible part of the machine could actually be measured it would ordinarily be found that this copper temperature would be approximately 15 C hotter for class A insulation or 20 C hotter for class B insulation, than anything that could otherwise be measured by the thermometer method. Also it would be approximately 5 C and 10 C hotter than anything that could be otherwise measured by the resistance or embedded detector method. This is due to the temperature gradient through the insulation or hot spot temperature, as it is sometimes called. Therefore, the standards that are set up make due allowances to guard against these differences in the method of temperature measurements.

The thermometer method uses thermometers on the ends of the stator coils, in the core ducts and on the core itself. This method gives the widest differences between "observed" temperatures and "actual" hot spot temperatures.

The embedded detector method uses thermocouples or resistance type temperature detectors placed between the lower and upper stator coil sides in the middle of the stator core and more nearly approaches the actual hot spot temperature. This method is restricted generally in its use to large equipment such as large generators, large motors, etc.

The resistance method determines the temperature rise by means of the increase in measured resistance of the winding. This method of course, gives "average" results and also more nearly approaches the actual hot spot temperature.

POSSIBILITIES FOR TEMPERATURE INCREASES

Consider some of the possibilities for temperature increases in several different kinds of rotating machinery.

Table II shows the possibilities of securing increased capacity from induction motors of larger capacity than the so-called general purpose class whose maximum limit is 200 hp. Here it will be noted that the usual rise specified for open type class A insulated motors by the thermometer method is 40 C. This means that induction motors of this class are rated on a fairly liberal basis.

It is suggested that the temperature rise be increased to 50 C by thermometer which would change the total limiting temperature which for this particular type of apparatus is 95 C, to 105 C.

Likewise, it is suggested that the class B insulation be stepped up by 10 C, thus changing the present total limiting temperature from 110 C to 120 C.

Table III shows that part of the A. I. E. E. committee report of January, 1943, restricting the ratings of small size alternating current motors with respect to determining loads. As stated before, this A. I. E. E. committee report parallels the War Production Board general conservation order L-221 which was issued in the early part of December, 1942.

Examining Table III, it will be noticed that in each case the maximum load allowed exceeds the selected 40 C motor rating by 25 per cent. This means that in order to conserve critical materials in emergency

cases, full advantage may be taken of getting the most out of such equipment with minimum material, even though the life of the equipment is considerably shortened. Table IV may be used as a guide for selection of general purpose induction motors, 200 hp and smaller. The limitations given will be somewhat in line with the WPB Limit order L-221 and the A. I. E. E. committee report, only with respect to the temperature rises by the thermometer method. The exact temperature rise expected under 25 per cent overload for this type of equipment will be explained more in detail later on.

As the maximum ratio of actual load to selected motor rating is given as 1.25, it is seen that the usual service factor of 1.15 has been exceeded. Therefore this figure has been made to approximate insofar as possible, corresponding temperature rise that might be obtained by the thermometer method at this degree of overloading. It should be specifically noticed that while the increased total limiting temperature standards might be exceeded by 10 C for class A insulation, that is, 115 C instead of 105 C, the total limiting temperatures for class B insulation are exactly the same as for the standards, namely, 130 C. As will be shown later, the life expectancy of the class A insulation under such total temperatures will be considerably reduced.

Table V shows that synchronous equipment such as synchronous motors and definite pole alternating current generators are usually specified with 40 C rise by thermometer for class A insulated stators, 50 C rise by hot resistance for class A insulated fields, and 70 C rise by hot resistance for class B insulated fields. The suggested increases are shown as approximately 10 C for class A stators, 20 C rise for class B stators, and 10 C rise for class B fields.

The W. P. B. and the A. I. E. E. guide for selection of direct current motors is shown by Table VI. Here it is to be noted that the horsepower load exceeds the 40 C motor rating by 15 per cent and not 25 per cent as was the case with the 40 C alternating current motors. The reason for this decrease in loading might possibly be due to the commutation limits that always have to be considered with machines of this class.

Table VII shows that possibility for securing increased capacity from direct current machines having a two-hour 25 per cent overload rating. It has been the general practice in certain industries to specify the same temperature rises for class B insulated machines as for class A insulated machines. This has resulted in total limiting temperatures at continuous load of 95 C for class A insulation and 100C for class B insulation. In other words, both of these limits are well under those set by the standards.

TABLE IV

Possibilities for Securing Increased Capacity from Induction Motors of General Purpose Classification (200 hp and Less)

Method	Usual temperature rises specified				Possible increased temperature rises that might be allowable				Possible increased total limiting temperatures			
	Class A insulation		Class B insulation		Class A insulation		Class B insulation		Class A insulation		Class B insulation	
	Stator	Rotor	Stator	Rotor	Stator	Rotor	Stator	Rotor	Stator	Rotor	Stator	Rotor
Thermometer	40 C	40 C	50 C	50 C	60 C	60 C	70 C	70 C	115 C	115 C	130 C	130 C
Resistance	50 C	50 C	60 C	60 C	70 C	70 C	80 C	80 C	115 C	115 C	130 C	130 C
Embedded detector	50 C	50 C	60 C	60 C	70 C	70 C	80 C	80 C	115 C	115 C	130 C	130 C

TABLE V

Possibilities for Securing Increased Capacity from Synchronous Motors and Definite Pole A-c Generators

Method	Usual temperature rises specified						Possible increased temperature rises that might be allowable						Possible increased total limiting temperatures					
	Class A insulation			Class B insulation			Class A insulation			Class B insulation			Class A insulation			Class B insulation		
	Stator	Rotor		Stator	Rotor		Stator	Rotor		Stator	Rotor		Stator	Rotor		Stator	Rotor	
		100% Pf	80% Pf		100% Pf	80% Pf		100% Pf	80% Pf		100% Pf	80% Pf		100% Pf	80% Pf		100% Pf	80% Pf
Thermometer	40 C	....	....	50 C	....	....	50 C	....	....	70 C	....	....	105 C	....	....	130 C	....	....
Resistance	50 C	50 C	50 C	60 C	70 C	70 C	60 C	60 C	60 C	80 C	80 C	80 C	105 C	105 C	105 C	130 C	130 C	130 C
Embedded detector	50 C	....	....	60 C	....	....	60 C	....	....	80 C	....	....	105 C	....	....	130 C	....	....

Considering that a total limiting temperature at continuous load for class A insulation would be 105 C, it would be possible to step up the usual temperature rises that have been specified, namely 40 C for shunt field windings and armature windings, and 55 C for commutator to 50 C and 65 C respectively.

If the class B insulation is stepped up from 40 and 55 C to 60 and 75 C respectively, the resulting limiting temperatures at continuous load would be 120 C and 115 C respectively, which is under the value of 130 C set by the standards. Under such a rerating program, the 2 hr overload condition on these machines would have to be restricted to 15 per cent to hold the values to those set up by the standards.

On the other hand, the usual rises specified for turbo generators, Table VIII, is 60 C rise by embedded temperature detector for either class A or class B insulated stators, while for the rotors on these same machines the rise allotted by the resistance method is 85 C. Possibilities for this type of equipment are quite limited, due in large part to their relatively small diameter and great length, and include no increase for class A stator coils, a step up of 20 C for class B insulated stator coils, and no increase for the class B insulated rotors.

TABLE VI

Guide for Selecting Hp Ratings of Direct Current Continuous Rated 40 C Motors

If the hp load		Select
Exceeds	And does not exceed	D-c 40 C motor rated
.86	1.15	1 hp
1.15	1.72	1½ hp
1.72	2.3	2 hp
2.3	3.45	3 hp
3.45	5.75	5 hp
5.75	8.62	7½ hp
8.62	11.5	10 hp
11.5	17.2	15 hp
17.2	23.0	20 hp
23.0	28.7	25 hp
28.7	34.5	30 hp
34.5	46.0	40 hp
46.0	57.5	50 hp
57.5	69.0	60 hp
69.0	86.2	75 hp
86.2	115.0	100 hp
115.0	143.7	125 hp
143.7	172.0	150 hp
172.0	230.0	200 hp

APPROXIMATION OF TEMPERATURE RISE FOR DIFFERENT LOADING

It is one thing to consider possibilities of increasing the temperatures of machines by overloading, and another thing to obtain some reasonably accurate ideas as to what these temperature rises might mean in actual values of current loads. For this reason it is always best when considering overloads, to know what the temperatures are under a definitely known condition of loading, rather than by using the name plate values. If the two known conditions of temperature and loading (one at a low value of load or without load, and the other at some definite load such as full load) can be obtained, plotting these two points on regular

TABLE VII

Possibilities for Securing Increased Capacity from Direct Current Machines Having a 2-Hr 25% Overload Rating

Usual temperature rises specified									Resulting total limiting temperatures at continuous load	
Load	At continuous load				At end of 2-hr 25% overload, following continuous full load					
Class of insulation	Class A		Class B		Class A		Class B		Class A	Class B
Method	Therm	Res	Therm	Res	Therm	Res	Therm	Res		
Shunt field windings	40	50	40	50	55	65	55	65	95	100
Armature windings	40	.....	40	.....	55	.....	55	.....	95	100
Commutator*	55*	.....	55*	.....	65*	.....	65*	.....	95	95

Possible increased temperature rises that might be allowed									Resulting total limiting temperatures at continuous load	
Load	At continuous load				At end of 2-hr 15% overload, following continuous load					
Class of insulation	Class A		Class B		Class A		Class B		Class A	Class B
Method	Therm	Res	Therm	Res	Therm	Res	Therm	Res		
Shunt field windings	50	60	†60	†70	65	75	†75	†85	105	120
Armature windings	50	.....	†60	.....	65	.....	†75	.....	105	120
Commutator*	65*	.....	†75*	.....	75*	.....	†85*	.....	105	115

*All commutators have class B insulation and no allowance is made for temperature drop for commutator temperature by thermometer.
†A. S. A. Standards.

TABLE VIII

Possibilities for Securing Increased Capacity from 1800 and 3600 Rpm Turbo-Generators (All Rotors have Full Class "B" Insulation)

Method	Usual temperature rises specified						Possible increased temperature rises that might be allowable						Possible increased total limiting temperatures					
	Class A insulation			Class B insulation			Class A insulation			Class B insulation			Class A insulation			Class B insulation		
	Stator	Rotor		Stator	Rotor		Stator	Rotor		Stator	Rotor		Stator	Rotor		Stator	Rotor	
		100% Pf	80% Pf		100% Pf	80% Pf		100% Pf	80% Pf		100% Pf	80% Pf		100% Pf	80% Pf		100% Pf	80% Pf
Thermometer	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Resistance	....	....	....	....	85 C	85 C	....	....	....	....	85 C	85 C	....	....	....	....	135 C	135 C
Embedded detector	60 C	....	....	60 C	....	....	60 C	....	....	80 C	....	....	105 C	....	....	130 C	....	....

cross-section paper as in Figure 9 and extrapolating in a straight line will give for any actual temperature limit set, the overload which is determined by working back through the abscissae value, which is the relative value between the actual stator current and the rated stator current squared, reduced to a basis of 75 C reference temperature.

Referring to Table IV, it will be noticed that for the thermometer method for class A insulation under usual temperature rises specified of 40 C that the possible increased temperature rise under 25 per cent overloading might be 60 C rise. In other words, there is a difference between these two points, namely 40 C and 60 C, or 20 C. If, however, for the same difference in rise, namely, 20 C for instance between 50 and 70 C for class A insulation, or between 60 C and 80 C for class B insulation, it will be noted that the overloading represented by these different conditions will vary widely, giving 28 per cent overload from 40 to 60 C, 21 per cent overload from 50 to 70 C, and only 17 per cent overload from 60 to 80 C. This means that when considering overload ratings, careful consideration must be given to a reasonable method of predetermining the temperature rises that might be expected under a definite overload condition. The method shown by Figure 1 is much more accurate than that obtained by using the value of current squared times a known rise at a definite loading. As stated before, the known conditions should preferably be obtained from actual loading and for more than two different points if at all possible.

LIFE OF INSULATION

Class A insulation — Figure 2 shows two life curves for class A insulation. The upper was established about 1925 and represents the life of class A insulation in air. This is sometimes known as the 10 degree life curve, in that the insulation life is approximately halved for every 10 degree increase in temperature. The lower curve was brought out by Mr. Montsinger of the General Electric Company about 1930 and was established by tests of insulation immersed in oil. This curve is commonly referred to as the 8 degree curve, in that for every 8 degree rise in temperature the insulation life is halved.

There are still differences of opinion as to which of these curves should be used because insulation life can be gauged by so many different methods such as for instance,

A. Electrical methods
   1. Insulation resistance
   2. Electric breakdown
   3. Power factor
   4. Dielectric loss
B. Mechanical limits
   1. Physical condition by observation
   2. Cracking and bending on various sizes of radius
   3. Flexibility
   4. Tensile strength
   5. Folding endurance

TABLE IX

Short Time Temperature Calculations

Motor = 1000 hp thermal time constant T = 14.4 minutes
Known rise at full load by embedded temperature detector = 42 C
Y = 75 C

How long can motor be run at 35% overload in current without exceeding 55 C rise by embedded detector when the ambient temperature = 30 C.

Case 1	Case 2	Case 3
Starting cold at room temperature	Same as case 1 except Starting when motor has already been running at full load 42 C rise	Same as case 1 except Starting after motor was running idle with practically no load and 7 C rise
y = 55 C y_0 = OC Y = 75 C t = 19 minutes	y = 55 C y_0 = 42 C Y = 75 C t = 7.2 minutes	y = 55 C y_0 = 7 C Y = 75 C t = 17.6 minutes

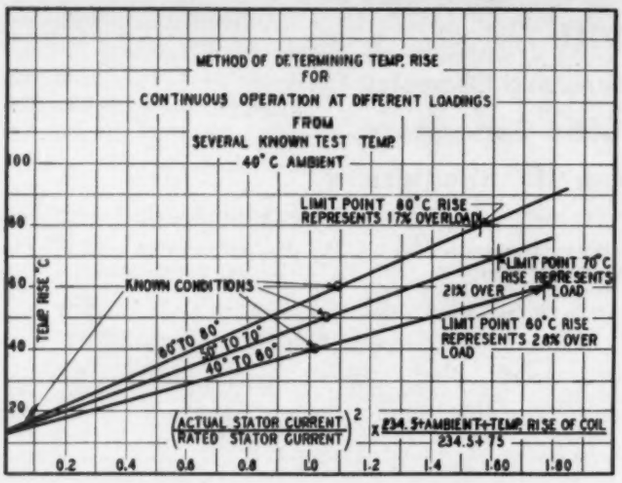


Figure 1 — Method of determining temperature rise for continuous operation at different loadings from several known test temperatures.

Because the life of class A insulation is very greatly affected if there are slight traces of acid in the oil, as recently discussed at the Midwest Power Conference in Chicago, the life of class A insulation has been represented as a band, Figure 3, so that the heavy, straight line through the approximate center of this band gives a definite yard stick from which to gauge insulation life, and at the same time shows the maximum and minimum limits of insulation life which might be expected under various temperatures. At 105 C the insulation life varies from 8½ to 23 years with the solid line within the band showing a life of 15 years. It will be remembered that 105 C is a total limiting temperature for class A insulation as set up by the standards.

Looking closely at the solid or heavy line life curve, it will be noticed that if a temperature of 95 C is maintained for a period of 29.2 years, the class A insulation will theoretically reach the end of its useful life and will be subject to failure under mechanical or electrical shock. At 105 C, the value drops to 15 years, thus as previously stated, for every 10 degree increase in temperature the insulation life is approximately halved.

From this it can be seen that machines operating at 40 C rise by the thermometer method in an ambient of 40 C having a total limiting temperature of 95C, would have a life expectancy of 29.2 years, but if the rating were increased until the rise was 115 C, as previously discussed in connection with Table IV, then the insulation life would be reduced to 8 years, or about ¼ of that which might ordinarily be expected.

While these values are referred to as theoretical, such a life curve permits the making of reasonable estimates as to the life span of this type of insulation. The relation between the life expectancy of insulation as indicated by laboratory and field tests, and the life of insulation of any given machine, is in itself an estimate. The use of such information must be tempered by good judgment based on operating experience.

Naturally very few machines operate continuously at their maximum rated temperatures so that the life expectancy of insulation operating at lower temperatures may be very much extended.

Undoubtedly, there are electrical machines that have been in more or less continuous operation for long periods of time such as 25, 30 or 40 years, etc., and many of them are still in operation.

It is obvious, however, that in figuring depreciation so that the investment can be amortized in a reasonable time, it is very doubtful whether it would be considered good business to use 40 years, but rather 15 to 20 years as a maximum for obsolescence and replacement.

Class B insulation — No similar life curve data are available for class B materials. At the present time it is assumed that the life of a winding with class B insulation is greater for class A temperature rises than for class B temperature rises. While class B materials are not appreciably susceptible to deterioration from the high order of temperatures encountered in some service conditions, the bonding materials that are used in these materials are greatly affected, and the life expectancy is dependent to a considerable extent by the deterioration of the bonding material.

THERMAL TIME CONSTANT

It is a well known fact that every piece of electrical equipment has what is called a "thermal time temperature constant" which is indicative of the rate at which the temperature rises with respect to time.

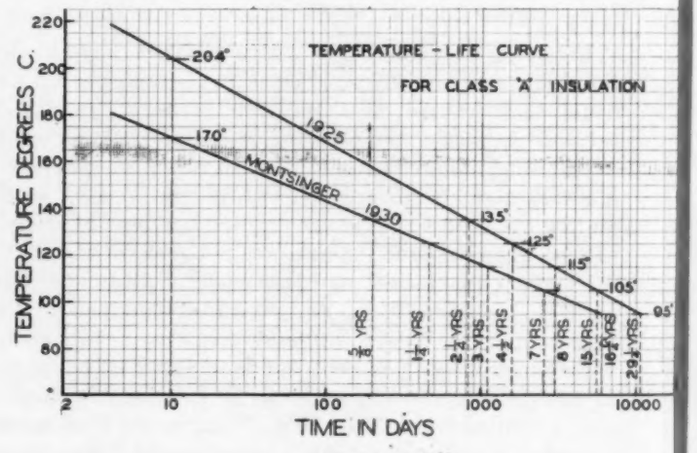
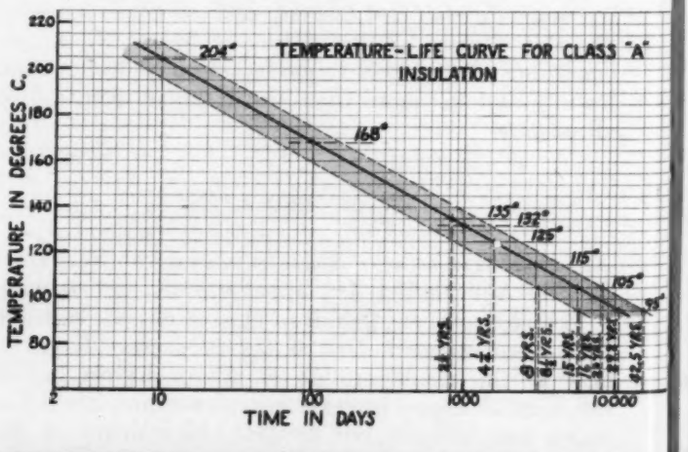


Figure 2 — Temperature-life curves for class A insulation.

▲

Figure 3 — Temperature-life curve for class A insulation.



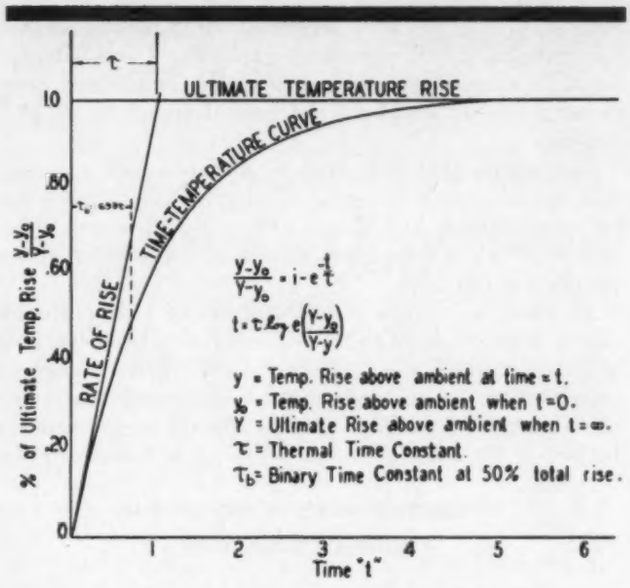

τ
ULTIMATE TEMPERATURE RISE
TIME-TEMPERATURE CURVE
RATE OF RISE
% of Ultimate Temp. Rise $\frac{y-y_0}{Y-y_0}$
$\frac{y-y_0}{Y-y_0} = 1-e^{-\frac{t}{\tau}}$
$t = \tau \log_e \left(\frac{Y-y_0}{Y-y}\right)$
y = Temp. Rise above ambient at time = t.
y_0 = Temp. Rise above ambient when t=0.
Y = Ultimate Rise above ambient when t=∞.
τ = Thermal Time Constant.
T_b = Binary Time Constant at 50% total rise.
Time "t"

Figure 4 — Time-temperature curve, with equation for the curve.

This time constant is established from the initial and ultimate temperature rise obtained from the curve, Figure 4, of time versus temperature, so that a tangent to the curve at the origin intersects the ultimate rise at a point that is called the thermal time constant. These time-temperature curves have the interesting property in that at 50 per cent of the ultimate rise, the time is always 69.3 per cent of the time constant, and further, that a tangent to the curve at any point intersects the ultimate rise at a point one time constant farther to the right than the point of tangency to the curve.

Therefore, if it is known from actual test what the thermal time constant of a machine is, and its initial heating and temperature rise during any single condition of loading, then it is possible to calculate its temperature rise under any other load condition, whether it is for continuous loading or short time loading.

The equation for the curve as well as the equation for the time "t" are also shown by Figure 4.

Different machines naturally have different time constants and usually, the larger the machine, the longer or greater the time constant.

By referring to Figure 5, the results will be seen of super-imposed loads by actual tests on a 2500 hp, 3600 rpm, squirrel cage induction motor which has a time constant of 15 minutes. It will be noticed that the original loading is 2000 hp and that after constant temperatures had been obtained for this condition, the load was then stepped up to 2500 hp and then again to 2875 hp. The same type of super-imposed loading is seen by examining Figure 6. Here a 700 hp squirrel cage induction motor was loaded first at 700 hp, then 800 hp, and finally 920 hp. In both of these cases, the temperatures were taken by the embedded detector method.

If the time constant had been known for either machine, and the constant temperature at any other load had also been known, it would have been possible to calculate within reasonably accurate limits, the temperatures at the other two loads rather than to make actual heat runs.

Often thermal time constants and temperature rises from similar equipment can be used in calculating temperatures for new equipment. Designing engineers often make use of this method for predicting temperatures for all kinds of different loadings.

USE OF TIME CONSTANTS

Assume that a 1000 hp induction motor has already been given a time temperature heat run at full load, and at this constant continuous load, the temperature rise was known to be 42 C by the embedded detector method, the thermal time constant was known to be 14.4 minutes, and the temperature rise of the motor when running idle at full speed without load other than the magnetizing current was 7 C.

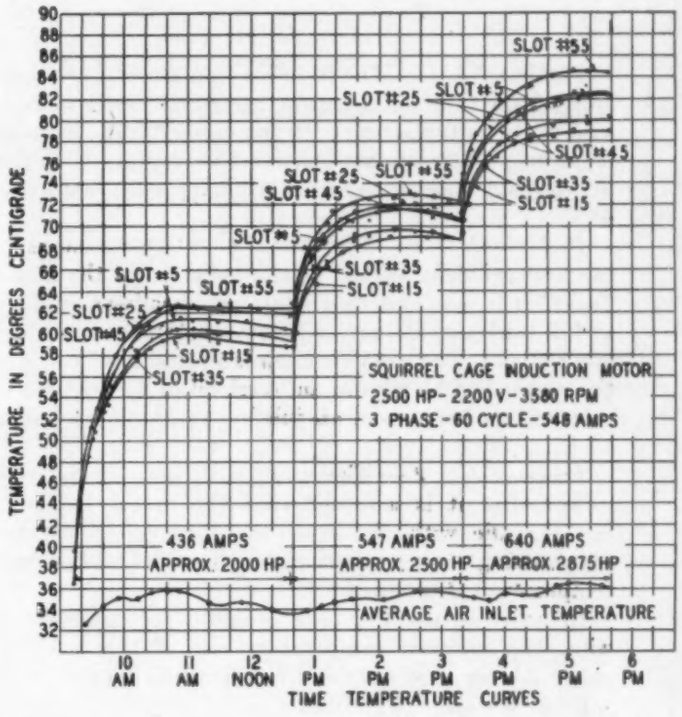


Figure 5 — Curves showing temperatures in various positions in a squirrel cage motor under increasing loads.

▲

Figure 6 — Time-temperature curves from a 700 hp squirrel cage motor under varying load.

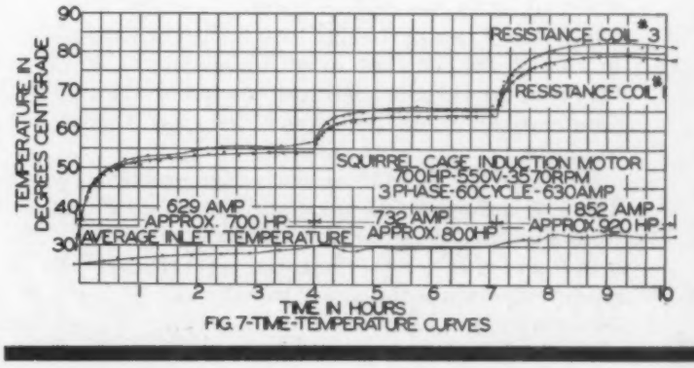


FIG. 7-TIME-TEMPERATURE CURVES

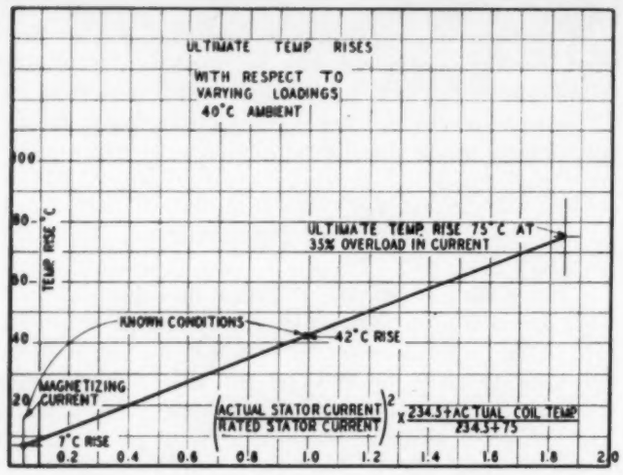


Figure 7 — Ultimate temperature rise in relation to varying load.

Problem No. 1 — The problem is to ascertain for how long a time this motor can be run at 35 per cent overload in current, starting with the motor "cold" at room or ambient temperature, without exceeding 55 C rise by embedded detector in an ambient temperature of 30 C.

Problem No. 2 — The same conditions exist as in the first problem, except instead of starting the motor "cold" it is assumed that it already has been running at full load and has arrived at a constant temperature of 42 C rise. The problem then is to find out how long the motor can be run on an overload of 35 per cent in current, super-imposed on full load without exceeding 55 C.

Problem No. 3 — The same conditions again exist except that it is assumed that the motor has been running idle with practically no load except for the magnetizing current and has arrived at a constant temperature at a rise of 7 C.

In order to use the time constant for ascertaining what the ultimate temperature rise of this machine under 35 per cent overload continuously would be, it will be necessary to go back and lay out the conditions similar to that in Figure 1. This is shown by the curve in Figure 7. Here at abscissa value of slightly less than 1.0 the point of 42 C rise is shown, and for the magnetizing current at almost zero load, the point of 7 C rise is shown. Joining these two points and extrapolating up to an abscissa value that would be equivalent to an overload of 35 per cent in current, namely, 1.84, it is found that if this particular 1000 hp motor were allowed to run at 35 per cent overload in current until the temperature became constant, it would then have a temperature rise of 75 C, which, for class A insulation, would be beyond safe limits.

Transferring these three particular problems over to Table 9 and using the ultimate rise of 75 C obtained from Figure 7, and the time constant of 14.4 minutes, it is found that for the first case of starting "cold" at room temperature the motor would reach 55 C rise in a 30 C ambient in 19 minutes. In the second case, starting after the motor had already been running at full load with 42 C rise, the 35 C overload could be maintained for only 7.2 minutes without exceeding the 55 degree limit. In case three, starting after the motor had been running idle at 7 C rise, the time is found to be 17.6 minutes.

The reason that temperature is emphasized so much is because not only is insulation life very greatly affected by temperature, but also a very good idea should be had as to what temperatures will actually exist under overload conditions.

As there is considerable variation of temperatures, due in large measure to the different structural features of different machines, it is always well when considering possible changes in loading to be guided by the name plate ratings on the individual machines in question, or far better, by actually known tests or load temperatures.

OVERLOAD CONSIDERATIONS IN TURBO-GENERATORS

Considering a hypothetical case of a turbo-generator where it is definitely known that the steam end of the unit as well as all of its associated equipment is capable of carrying any true load up to as much as 25 per cent overload.

Table 10 gives the name plate rating of this generator as follows: continuous full load current rating of 1000 amperes at 80 per cent power factor, with a temperature rating of 60 C rise on its class A insulated stator coils and 85 C rise on its class B insulated rotor coils, using embedded temperature detectors in the stator windings and resistance of the rotor windings. The maximum field is given as 300 amperes.

Assume that this machine has been operating 7 years, that it has always carried approximately its full rated load at rated power factor at all times, that the actual field current under these conditions was 270 amperes; and, that the ambient temperature has always been approximately 40 C under such loading.

TABLE X

Hypothetical Turbo-Generator

NAME PLATE RATING 1000 amperes 80% power factor
60 C rise stator windings by embedded detectors
85 C rise rotor windings by hot resistance
300 amperes maximum field excitation

CLASS OF INSULATION Class A for stator coils
Class B for rotor coils
In operation for 7 years at full load of 1000 amperes and 80% power factor 40 C ambient.

ACTUAL TEST READINGS under operating conditions
50 C rise stator windings
68 C rise rotor windings
270 amperes field excitation

TRIAL LOADINGS

$$\text{Stator } \left(\frac{1250}{1000}\right)^2 \times 50 = 78 \text{ C rise}$$

$$\text{Stator } \left(\frac{1090}{1000}\right)^2 \times 50 = 59.5 \text{ C rise}$$

$$\text{Rotor } \left(\frac{300}{270}\right)^2 \times 68 = 84 \text{ C rise}$$

Actual test readings made under installed conditions indicated that this generator has a capacity over and above that given by the name plate and that under normal full load conditions, the stator rise by embedded detector is only 50 C instead of 60 C as indicated on the name plate and the rotor temperature rise by hot resistance with 270 field amperes, was only 68 C instead of 85 C.

These known conditions give a definite basis from which to estimate a possible increase in load, and under such new loading, what the life expectancy of the machine under the new conditions might be.

Consider first the problem in its general aspects. It is understood, of course, that the reactive load any generator can carry within rated kva is limited by the heating of its field. If a load of lower and lower power factor is gradually put on such a machine, the condition that may finally exist will be such that the terminal voltage cannot be maintained. If the load is great enough and the power factor of same is low enough even maximum excitation will not be able to maintain full voltage.

In securing increased capacity from present generating equipment very definite consideration must be given not only to the amount of the load but also the "kind" of load, i.e. the power factor of the load that is to be added to the generator. If the field excitation of the generator is at a maximum and cannot be increased due to maximum temperature limitations, then any additional load that is to be added should have a power factor better than that of the generator itself, probably 90, 95 or 100 per cent, if the generator is rated at 80 per cent power factor. Overloading with noninductive loads, insofar as heating is concerned, carries the least hazards. Inductive loads of lower power factor than the generator should not be considered, unless they are relatively small, or unless the generator is pretty much underloaded and has some field margin left to go on.

DETERMINATION OF TRIAL LOADINGS

As a method of approach to overloading, assume that the stator might carry an overload of 25 per cent with a field current of 300 amperes which would be sufficient to provide for a load of 1250 amperes at 80 per cent power factor. Making a rough check by assuming that the temperature rise to the stator is proportional to the square of the current, and knowing that the actual temperature rise of 1000 amperes load was only 50 C by embedded detector, the approximate temperature rise on this new basis would be approximately:

$$\left(\frac{1250}{1000}\right)^2 \times 50 = 78 \text{ C}$$

This would be beyond the limits of 60 C rise that might be considered as safe for operation.

Therefore, by this approximate trial and error method, it will be found that a 9 per cent additional load in current, making a total of 1090 amperes would give:

$$\left(\frac{1090}{1000}\right)^2 \times 50 = 59.5 \text{ C rise}$$

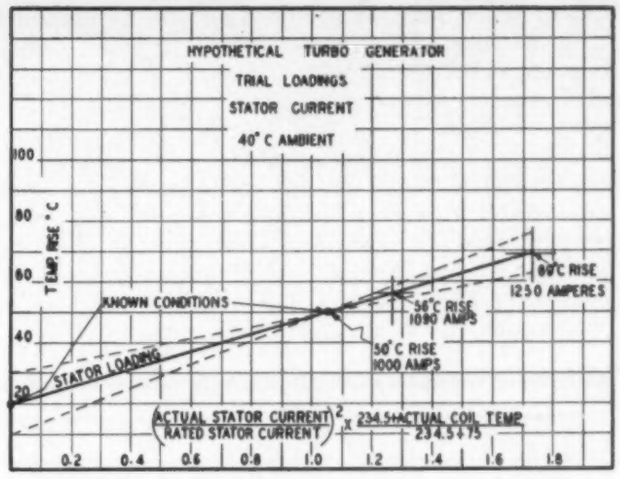
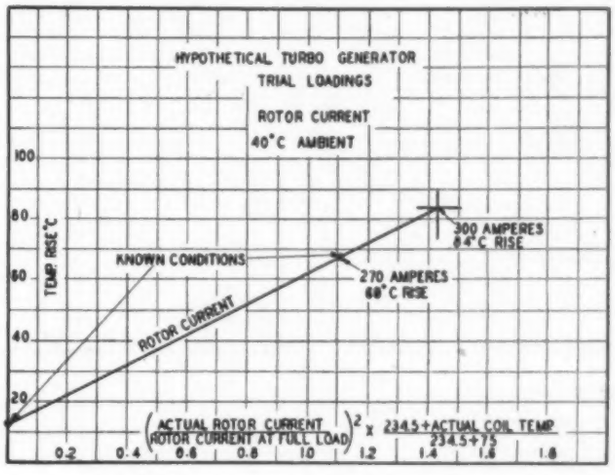


Figure 8 — Temperature rise for hypothetical turbo generator under varying stator current.

▲

Figure 9 — Temperature rise for hypothetical turbo generator under varying rotor current.



This is very close to the maximum rise of 60 C which has been satisfactory as the limit for class A insulation.

In checking this method of approximation as shown by Figure 8, the 50 C rise is plotted for an abscissa value of 1.05, while at zero stator current the intercept on the origin is shown at zero abscissa value as 20 C, which rise is due to windage, friction, and core losses. Joining these two points and extrapolating it is found that at 1250 amperes the temperature would be more nearly 69 C rise rather than 78 C rise as by the method of approximation, and at 1090 amperes would be 56 C rise rather than 59 C rise as by the current squared method.

In determining temperature rises under overload conditions by the method shown in Figure 8, care must be exercised in the location of the "zero" load point, because if accurate data is not obtained and if the "zero" load point were taken as 30 C temperature rise instead of 20 C temperature rise, then at 1250 amperes the rise would be established as 62 C instead of 69 C, and at 1090 amperes as 53 C instead of 56 C.

Likewise, by taking the point too low, such as 10 C

rise instead of 20 C rise, distorted and untrue values arising under overload conditions would be obtained.

Furthermore, if the load temperature point should be taken at fairly light loads and might be considerably off from the actual temperature existant, then the errors by extrapolating both the two known conditions would still further be exaggerated.

Having determined that for a trial loading the maximum stator current which the generator can safely carry is 1090 amperes, and knowing that the temperature by hot resistance of the rotor from actual loading for 270 amperes is 68 C rise, the field winding temperature rise at maximum field current of 300 amperes using the same method of approximation for estimating temperatures would be, therefore:

$$\left(\frac{300}{270}\right)^2 \times 68 = 84 \text{ C rise}$$

Again checking this by extrapolation of known conditions, Figure 9, it is found that if the temperature at zero ordinate is 12 C, then by extrapolation, the rise for 300 field amperes is 84 C. In this particular case this figure checks exactly with that shown by the current squared method.

It is much safer, however, to take more than two actual load test points of temperature rise of both stator and rotor windings, as shown by Figure 10, and plot these in curve form. By doing this, it will always be known that selected load points are in line with the curve and can be considered correctly. Isolated test points, due to errors that are likely to creep in, may be badly off and may lead to erroneous and dangerous conclusions.

Because conditions are subject to change, the ventilation ducts in the stator and rotor becoming clogged with dirt, the air filters becoming dirty, etc., the curve of temperature rises if checked at frequent stated intervals will usually be informative to the operator that something is wrong and needs investigation.

It is much better that such curves be determined under installed conditions, preferably at rated power factor, because installation conditions may be considerably different than any test that it might have been possible to make at the factory.

KINDS OF LOAD

Figure 11 shows the manner in which these two limits of stator and rotor current affect the loading of the generator.

Point "A" is the rated load point, 1000 amperes at 80 per cent power factor with 270 amperes field excitation. The line OA can be considered as a vector representing rated full load current in its proper time phase relationship.

At 80 per cent power factor, 1000 amperes can be divided into two components, 800 amperes, OB, in phase with the voltage representing the power component, and 600 amperes, OC, in quadrature with the voltage, representing the "wattless" component.

The stator current limit of 1090 amperes which was determined in the manner shown above can then be represented by the arc MNQ drawn with O as its center.

The curved lines DAE and PNR represent the field heating limits for 270 and 300 amperes respectively, as discussed previously.

These curved lines of field current are established from the known excitation characteristics of the particular machine under consideration and are subject to variation with different generators. For purposes of trial loadings, they can be based on "average"

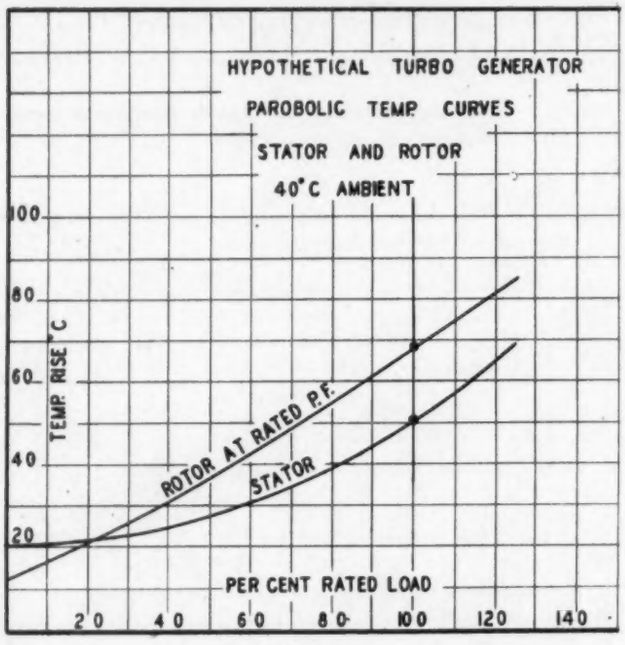


Figure 10 — Parabolic temperature curves for rotor and stator of hypothetical turbo generator under varying load.

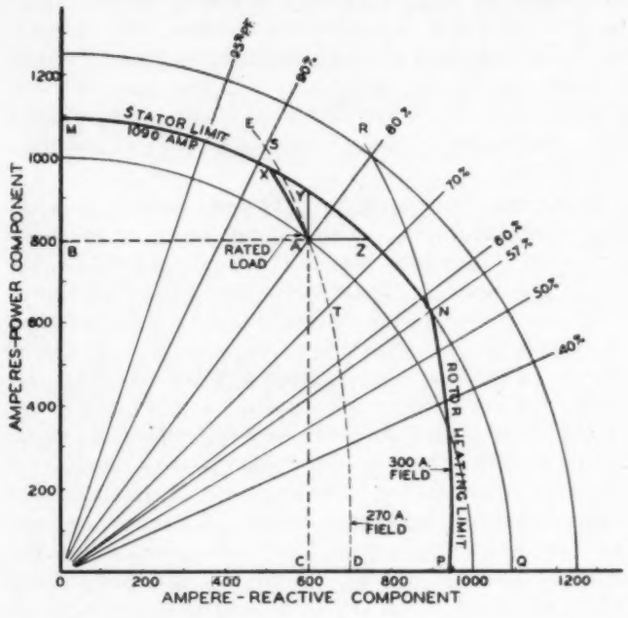


Figure 11 — Rotor and stator load limits of a turbo generator.

conditions that can later be verified by actual tests.

For instance, it will be noted that the curved line EAD, 270 ampere field, intersects the 90 per cent power factor line at S with a primary current of OS, the 80 per cent power factor line at A with a primary current of OA, the 70 per cent power factor line at T with a primary current of OT, and so on. This means that with a field of 270 amperes, the excitation characteristics of the machine are such that rated voltage can be maintained with different primary loadings at various power factors. While these loadings at different power factors merely represent the general characteristics of the generator, they do not mean that all such loadings can be maintained under "constant" load conditions because it is already known that there is a definite heating limit to maximum safe primary current that can be carried.

For example, it will be noted that the line RNP, representing 300 amperes field excitation, intersects the 80 per cent power factor line at 1250 amperes, which value is beyond the safe operating limit of the stator.

Since the maximum load from a temperature standpoint is governed by the two limits of stator current and rotor current, it is plain that the maximum loading of the generator must terminate on the heavy line MNP.

In the region from M to N, the load is limited by the stator, and in the region from N to P, the load is limited by rotor heating. Thus, at point N, the generator can carry 1090 amperes at 57 per cent power factor with a field current of 300 amperes. This load represents the tentative limiting condition for both stator and field.

Additional loads, super-imposed on the normal rated load of the generator, can be represented by a vector such as AY for a unity power factor load, AZ for a zero power factor load, or AX for a leading power factor load. The total resulting load on the generator in terms of primary or stator current, would be OY, OZ, and OX respectively, or 1090 amperes.

Because this particular hypothetical generator has a greater maximum field limit than would normally be required, and because the loadings shown are within the working range of the field limit of 300 amperes, such loads will naturally require varying values of field currents less than 270 amperes for the leading power factor loading OX, to values exceeding this amount for the OY and OZ loadings that are still within the 300 ampere field limit set. This applies to this particular case only.

Examining these loadings to a somewhat larger scale, Figure 12, it is seen that great care must be exercised in the "kind" of additional loading that is put on the generator. The examples given show the possibilities for adding a 100 per cent power factor load AY with an overall power factor of the generator of 83.5 per cent, a zero power factor load of AZ with an overall power factor of the generator of 73.5 per cent and a 94 per cent leading power factor load of AX with an overall power factor of the generator of 85.5 per cent.

Now consider the addition of maximum loading to 1090 amperes which is comprised of both reactive and power load and ascertain what the power factor of this extra loading would be, keeping within the 300 amperes field excitation.

With a wattless load of AG and a power load of GV, the power factor of this loading would be 80 per cent and the power factor of the total load would be 80 per cent.

A wattless loading of AH and a power loading of HU would have a power factor of 96.5 per cent, but the overall power factor of the generator would change from 80 to 81.9 per cent.

A wattless loading of AJ and a power loading of JL would have a power factor of 51.5 per cent and the overall power factor of the generator would change from 80 to 78 per cent.

The only way in which the new temperature rises under the new loading conditions can accurately be ascertained would be by means of an actual load test. Where large additional loading seems feasible, step by step incremental loading and actual testing is by far the safest method of approach to the problem rather than endeavoring to take on a proportionately large load at once.

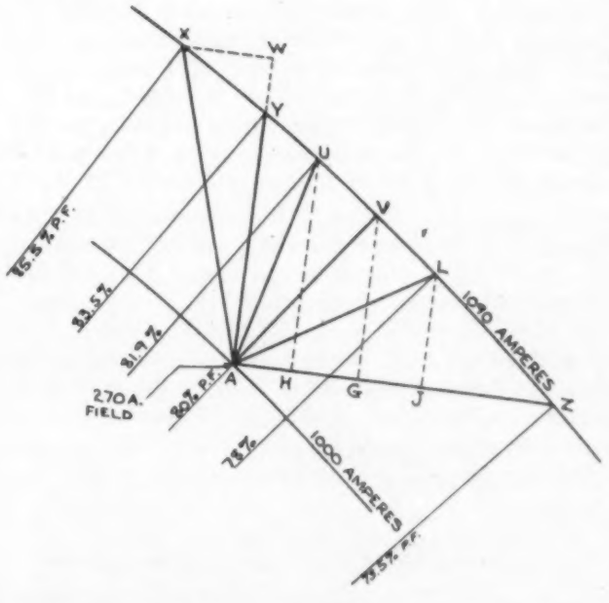
Small blocks of power, however, would not have to be tested out in split up units. It would be, however, in all cases advisable to actually test for temperatures rather than using rule of thumb methods.

Difficulty might be experienced in obtaining the proper amount and the correct power factor of additional load for certain cases. It would seem that in those cases where relatively small amounts of load are available, it would be advantageous to build up more non-inductive load provided the stability of the generator would still be satisfactory.

INSULATION LIFE

Referring back to the hypothetical turbo-generator to consider the life of the stator windings under the

Figure 12 — Maximum generator loading at various power factors.



increased loading of 9 per cent, where it was expected the temperature rise might increase from 50 C to 56-59½ C (say 60C) by the embedded temperature detector method.

A temperature rise of 50 C + 40 C ambient + 5 C hot spot gives a total limiting temperature of 95 C, Figure 13 which represents the original loading on the machine for 7 years, and indicates an insulation life of approximately 29.2 years if the machine had been allowed to operate continuously on the lower load basis of 1000 amperes. The insulation life line, LD, is the same as the heavy middle line shown previously on Figure 3.

A temperature rise of 60 C + 40 C ambient + 5 C hot spot gives a total limiting temperature of 105 C for a load of 1090 amperes that will be put on this machine after it has been operating for 7 years at the lower load of 1000 amperes. The question now is to find out how many more years this generator will operate at this higher temperature, before the insulation life is completed.

This can be approximated by using the following method:

Line AD, representing a temperature of 95 C, intersects the insulation life line, LD, at 10,650 days (29.2 years).

If it can be assumed that the insulation's life is expended uniformly as time goes on, then after 7 years at 95 C, represented by the line AC, the life would be

$(7 \div 29.2) \times 100 = 24$ per cent gone, or

$100 - 24 = 76$ per cent of the life remains

or $29.2 - 7 = 22.2$ years of the life remains.

Therefore 76 per cent of 10,650 days = 8100 days or 22.2 years which is represented by the line AN. Since the insulation life (abscissa) is plotted on a logarithmic scale, a line MN, when drawn parallel to LD through the point N, represents 76 per cent of the life shown by line LD. The additional life then can be expected under the increased loading (105 C) is determined by the intersection of the line MN with the 105 C line, EF, at point G. This value is approximately 11.8 years.

Similarly any other condition of increased or decreased temperatures can be approximated by first determining what percent of the total insulation life has been used up at the initial temperature and drawing a line corresponding to line MN based on this percentage. This line then shows the additional life of the insulation after the temperature has been increased or decreased by the intersection of that line with the horizontal temperature line in question.

To summarize, it should be remembered that field heating as well as stator heating will limit the amount of extra load a generator can carry. Stator heating depends on stator current, and here is a function of kva load. On the other hand, the load power factor, as well as the kva, determines the field current and thus the field heating. Other limiting factors, such as stability, differential expansion and contraction and operating cycles should also be given full consideration when contemplating any increases above rated load.

LIMITATIONS OTHER THAN TEMPERATURE

System stability — Increased kw loading of any generator invariably increases its chances of falling out of step due to system disturbances. The danger of losing synchronism is still greater, if the increases in load result in better power factor. It is important, therefore, that such things also be given careful study because, if the new loading appears unsatisfactory from a stability standpoint, certain changes in operating procedures, relays, circuit breakers for limiting the fault duration, and improved control of the generator exciter may have the remedial effects necessary.

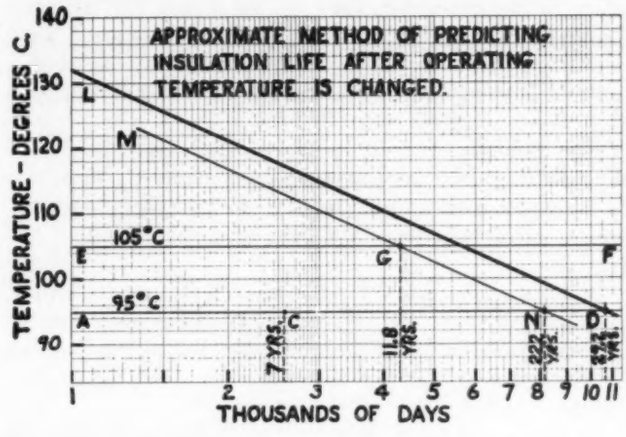


Figure 13 — Approximate method of predicting insulation life with changed operating temperature.

Differential expansion and contraction of stator windings — The wear and tear on insulation caused by the differential expansion and contraction effects between the copper and the iron becomes more pronounced at higher loads and higher temperatures, and more severe with sudden changes in load. The effect is greater in magnitude, the longer the machine becomes and for this reason applies particularly to high speed equipment of the turbo-generator class.

Characteristics of generators indicate average temperature differences, Figure 14, between the copper and the iron which become more pronounced as the load increases. Wherever possible it is desirable to have an actual test curve of the average temperature rise of both the embedded stator copper and the stator laminations. However, where such information is not available, Figure 14, approximates these differences when applied to fairly long core machines. For instance, at zero load, represented by 20 C rise of copper, the rise of the laminations is also 20 C, while at a higher copper temperature rise of 50 C, the lamination rise is shown as 35 C. The various copper temperature rises, can be further divided by test or approximation, into percentage of load to suit each and every case being studied.

Differential expansion and contraction between copper and iron, Figure 15, can then be ascertained by using the different temperature rises for the two different materials, from Figure 14, to obtain the expansion of each of the two materials and multiplying the difference by the length of the core.

Different load values obtained from Figure 14, can

be set up on Figure 15 to suit each individual case if desired. Also, the expansion can be determined for any ambient temperature other than 40 C by choosing the proper temperature scale for the abscissa.

To obtain some idea as to what these differences may be in actual figures, consider a turbo-generator having a core 100 in. long. Assume that Figures 14 and 15 are applicable to this particular generator which has an average copper rise at full load of 50 C in an ambient temperature of 40 C. From Figure 14, the average lamination rise is 35 C.

As the expansion of copper, Figure 15, at 50 C = .00108 in. per inch of core length and the expansion of laminations, Figure 15, at 35 C = .00051 in. per inch of core length, then the total differential expansion = 100 (.00108 — .00051) = .057 in.

For some other temperature conditions, the differential expansion and contraction could be as follows:

For 80 C rise — 100 in. core length = .092 in.
For 80 C rise — 150 in. core length = .138 in.
For 80 C rise — 200 in. core length = .184 in.

The reference temperature for Figure 15 is 25 C. That is, at 25 C the expansion of both the copper and the iron is taken as zero.

Such differential expansion changes mean that slippage of insulation on the coils or between the coil insulation and the core laminations must actually occur, and, if the changes are great enough and occur often enough, it finally results in a failure of the insulation.

Plastic deformation of rotor copper — In the larger types of turbine generators, a large part of the total length of the field copper may be clamped to the rotor slot wedges due to high radial forces due to centrifugal loading. If the rotor copper is heated while in this clamped condition, the stresses due to expansion may become great enough to plastically deform the rotor copper. The oftener this cycle of heating and cooling occurs, the more pronounced the deformation becomes and is usually associated with a shrinkage of the copper turns which become progressively more pronounced toward the radial center of the rotor slot, finally resulting in overlapping of the rotor copper conductors on the ends of the rotor until actual breakage of the copper occurs, or short circuits between turns develop.

To minimize these tendencies, the practice of using turning gears and that of keeping the machine at as nearly constant temperature as possible, whether shut down or in actual use, is gradually extending itself until undoubtedly a time will arrive when definite practices will be established for methods of operating such equipment.

General considerations — While such conditions apply particularly to long core machines, it shows that the question of the effects of temperature are not always confined to the life of insulation from purely a temperature standpoint.

In considering possibilities for temperature increases, therefore, it should be known as definitely as possible what such possibilities actually mean in the way of applying them in a simple yet definite manner in so far as the life of the equipment and obsolescense is concerned.

CONSIDERATION OF DIFFERENT TYPES OF EQUIPMENT

Synchronous motors and definite pole a-c generators — The procedure for this type of equipment is exactly the same as that for the turbo-generator. The maximum field heating has to be first ascertained before increased loading of the stator winding can be accomplished. Torque requirements, however, may preclude the possibility of operating at increased loads and higher temperature rise.

Induction motors — Induction motors can be approached in a different manner because there is no exciting field on the rotor to be considered. The great majority of induction motors are built for 40 C rise by the thermometer method for continuous full load. A "service factor" of 1.15 is available for most of these machines, which means that 15 per cent overload can

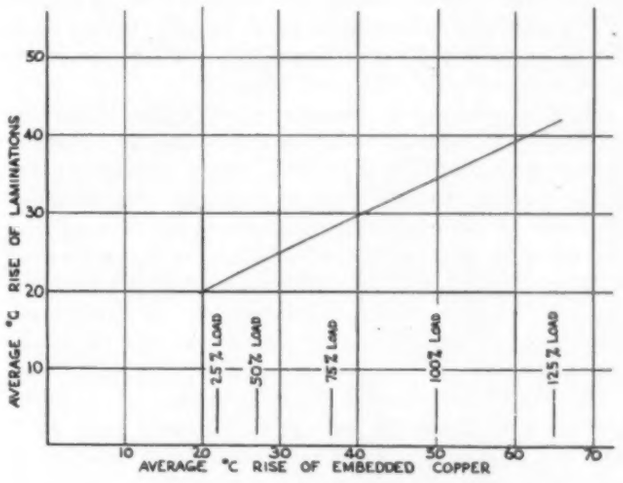
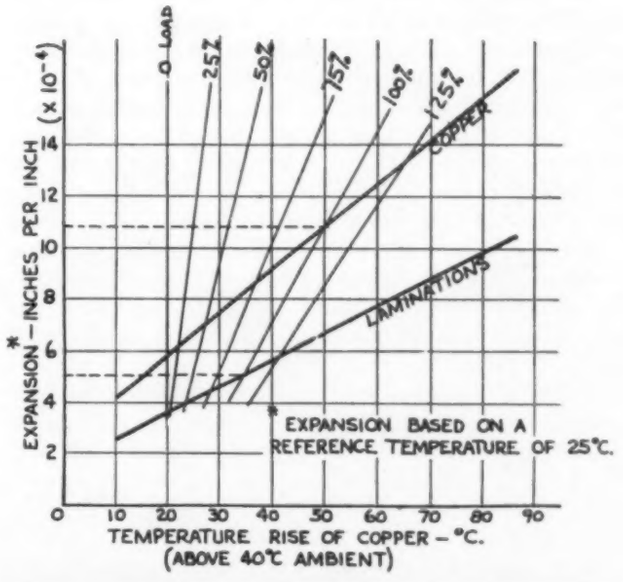


Figure 14 — Curve showing temperature variation between copper and laminations in a typical large generator.

▲

Figure 15 — Chart showing relative expansion of copper and laminations.



be carried continuously without injurious heating. Just what temperature or temperature rise constitutes injurious heating is not defined, but ordinarily, a motor that operates at continuous full load with 40 C rise, by thermometer might easily be expected to operate with approximately 50 degree rise or more on 15 per cent overload or at a total temperature of 105 C in a 40 C ambient temperature. This 10 degree higher continuous operating temperature is apt to about cut in half the expected insulation life. The life curve would show a reduction from 29.2 years to 15 years.

With 25 per cent overload as recommended by both the War Production Board and the A. I. E. E. sub-committee, Table III would mean a possible temperature rise of 60 C by thermometer, which would have a total possible temperature of 115 C and the insulation life would be cut from 29.2 years to 8 years.

In war plants, in war times, such loading may be fully warranted. However, good judgment is always needed. Other factors affecting the motor loading, such as starting torque, maximum torque, etc. must be fully considered. Sometimes these factors, rather than the continuous rating, determine the motor size. Such cases, however, are relatively few.

Direct current motors and generators — Direct current machines can be overloaded in much the same way as induction motors. The great majority of these machines in the general purpose class, at least, are also built for 40 C rise by thermometer for continuous full load and also carry a "service factor" of 1.15. At this increased load the commutation would be expected to be within reasonable limits, but the insulation life will be approximately cut in half. Large equipment and special applications should be considered in each individual case.

The War Production Board conservation order L-221 limits the ratio of the rating of d-c open type 40 C motors to not more than 87 per cent of the determined load. This is equivalent to a factor of 1.15. The A. I. E. E. sub-committee report of January, 1943, Table VI, dealing with restricted ratings for the same equipment limits the ratio to the same factor of 1.15. Both of these limitations refer more to new equipment to be purchased rather than to existing equipment.

Transformers — The load that can be carried on existing transformers can be increased by adding auxiliary cooling equipment such as radiator fans, external oil coolers, or water spray equipment. The amount of additional loading that such devices permit varies widely depending on the design characteristics of the transformers, the type of cooling equipment, the permissible increase in voltage regulation, and the limitations of associated equipment also.

If it is found that the bushings, leads, or other accessories are not a limiting feature, transformers, by the addition of any of these methods, may have the output increased in some cases as much as 25 to 67 per cent.

Switchgear apparatus — In general, switchgear apparatus is given a maximum rating based on permissible maximum temperature of operation. Under such conditions it is self-evident that the loading of switchgear equipment beyond its name plate rating is not recommended.

It is, however, generally true that switchgear has been applied with a considerable margin between the rating of the switchgear and the actual current requirements of the circuits in which they are used. Consequently, in a great many cases, the apparatus such as generators and motors can be loaded up without exceeding the rating of the switchgear apparatus in the circuit. It would, therefore, seem that only rarely would the problem of getting more load on the electrical machinery be effected by the rating of the switchgear involved.

In cases where the current rating of the circuit breakers might be lower than required in any given case where machines were being loaded up, it is possible in many cases, that by a redistribution of the breakers in a station or on a system, arrangements can be made for handling the increased load without the necessity of buying additional new equipment.

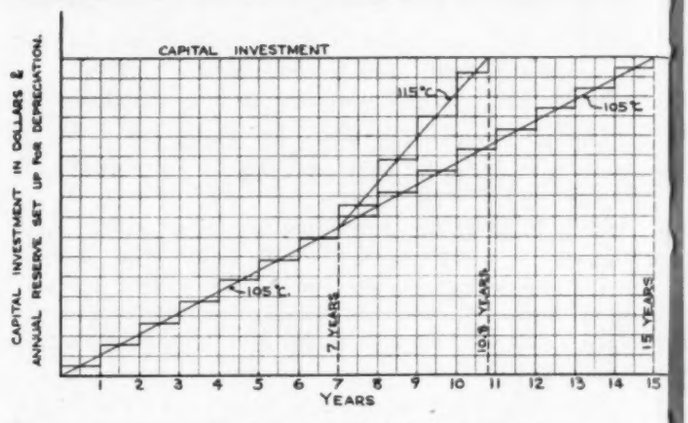


Figure 16 — Amortization of capital investment for varying life of equipment (interest charges not considered).

AMORTIZATION

In any financial structure involving capital investment it is generally good business to set aside a certain sum of money each year so that when the equipment involved becomes obsolete or worn out, funds will be available to cover the purchase of new and more efficient equipment.

In considering Figure 16 the maximum of the vertical ordinates represents an arbitrary total capital investment in dollars and the step curves represent the yearly annual amount set aside to amortize the total investmment when the equipment becomes obsolete, interest charges not being considered.

In the example shown, two different conditions are considered. First, a certain piece of electrical machinery with class A insulation was intended to be operated at a total limiting temperature of 105 C and at the end of 15 years it is assumed that the life of the machine is completed and will be replaced with new equipment. Second, the other case considered on this curve shows that the same machine is operated for a period of 7 years at the same total limiting temperature of 115 C.

As previously shown when stepping up the loading so that the total limiting temperature is raised to 115 C, the life of the equipment is reduced from 15 years to 10.8 years so that from the 7 year period on to the 10.8 period, an increased yearly amount of money should be

set aside to amortize the cost of the equipment at its obsolescence date. The fact must not be lost sight of, however, that from the 7 year period to the 10.8 period the overloaded machine is deriving a certain amount of additional revenue and therefore, the yearly increase in cost of the amortization is not the difference between the two sets of step curves but some value between the two limits shown.

CONCLUSION

It should be realized that temperature limits of insulation alone are not necessarily the yard stick from which to measure loading.

Some years ago a large wound rotor type induction motor operating in a steel mill had its "peak" loads gradually stepped up, little by little, until it was carrying recurrent intermittent maximum peak loads equivalent to three and one half times its normal load rating. Under this condition of loading, the motor temperature was low, something under 50 C rise by thermometer, but the solder in the rotor clips could not be maintained due to the high localized heating in this particular part of the machine which was in the first place never designed for such extremely high overload conditions.

The motor was finally replaced by a much larger motor and the rotor clips were specially designed and made to meet the high recurrent peak load conditions required.

This example is cited to show that ordinary electrical equipment is not always built like the so-called one-horse shay, where all component parts are so finely built, that when actual failure takes place, it occurs in all parts at one time.

Electrical equipment, therefore, cannot always be judged from its temperature limits alone, but rather, like the chain, from the weakest link in its structure. Such conditions might be due to limitations in mechanical parts, slip rings, brush capacity, cable connections, torque and current requirements, etc.

The question of securing increased capacity from present equipment is something that deserves the serious consideration of all manufacturers of such equipment, operators of such equipment and users of such equipment.

To conserve critical materials in time of emergency, full advantage can be taken of getting the most out of such equipment with minimum material, even though the life of the equipment is considerably shortened.

The movement, therefore, is such that it will affect not only old equipment, but it can be extended to usage of new equipment as well.

The approach to the subject, however, should be along reasonable lines, rather in the manner of the step-by-step fashion as already explained, especially for large generators already installed, so that the maximum limitations will be gradually approached rather than endeavoring to secure too much increased capacity at one time and later meeting with unforeseen difficulties.

BIBLIOGRAPHY

1. *Loading Transformers by Temperature*, by V. M. Montsinger. A. I. E. E. Journal, Vol. 48, 1930.
2. ASA C 50, January, 1936. *American Standards for Rotating Electrical Machinery.*
3. *Temperature and Life Characteristics of Class A Insulation*, by J. J. Smith and J. A. Scott, A. I. E. E. Transactions, Vol. 58, 1939.
4. *Rating of General Purpose Induction Motors*, by P. L. Alger and T. C. Johnson, A. I. E. E. Transactions, 1939.
5. *Deformation of Turbo-Alternator Rotor Windings Due to Temperature Rise*, by G. A. Juhlin, Journal of the Institution of Electrical Engineers, London, England, Vol. 85, October, 1939.
6. *General Principles upon which Temperature Limits are Based in the Rating of Electrical Machinery and Apparatus.* A. I. E. E. Number 1, June, 1940.
7. *Interpretation of Time Temperature Curves of Rotating Machines* by Fraser Jeffrey and R. M. Osborn. "Allis-Chalmers Electrical Review," June, 1941.
8. *General Conservation Order L-221.* War Production Board, December 2, 1942.
9. *Prevention of Rotor Winding Deformation on Turbo-Generators*, by John G. Noest. A. I. E. E. Technical Paper 44-85, March, 1944.

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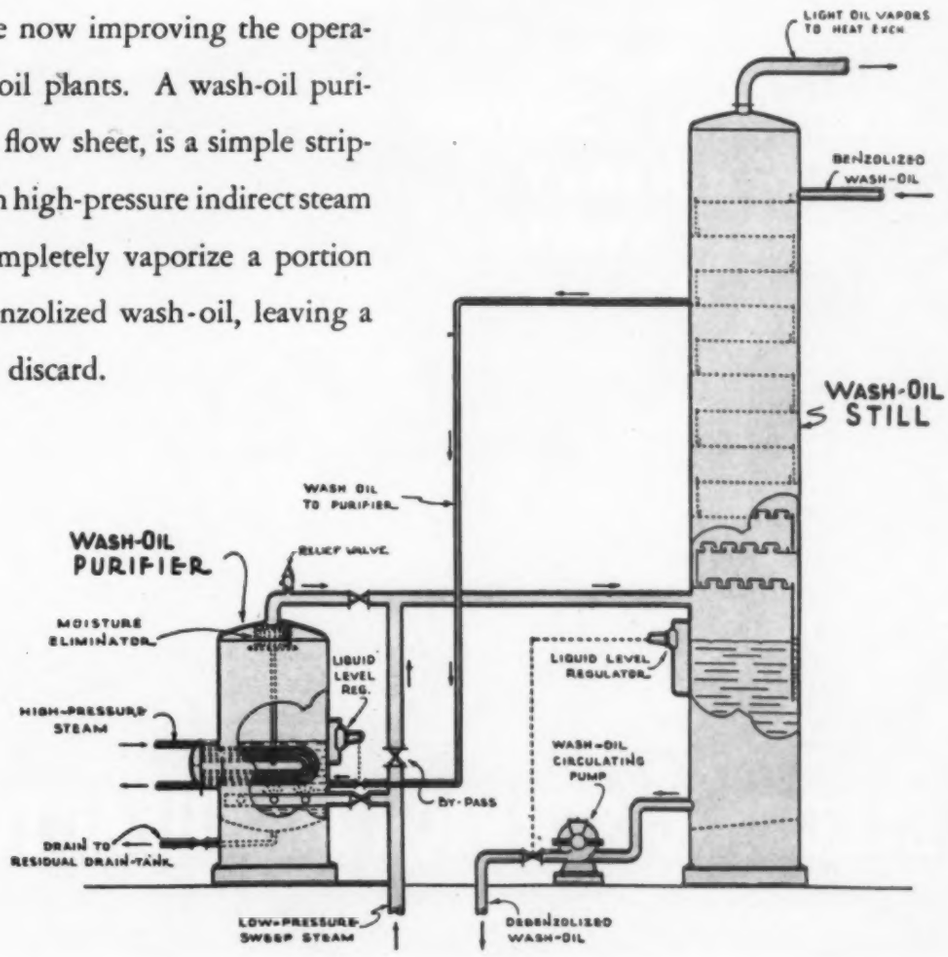
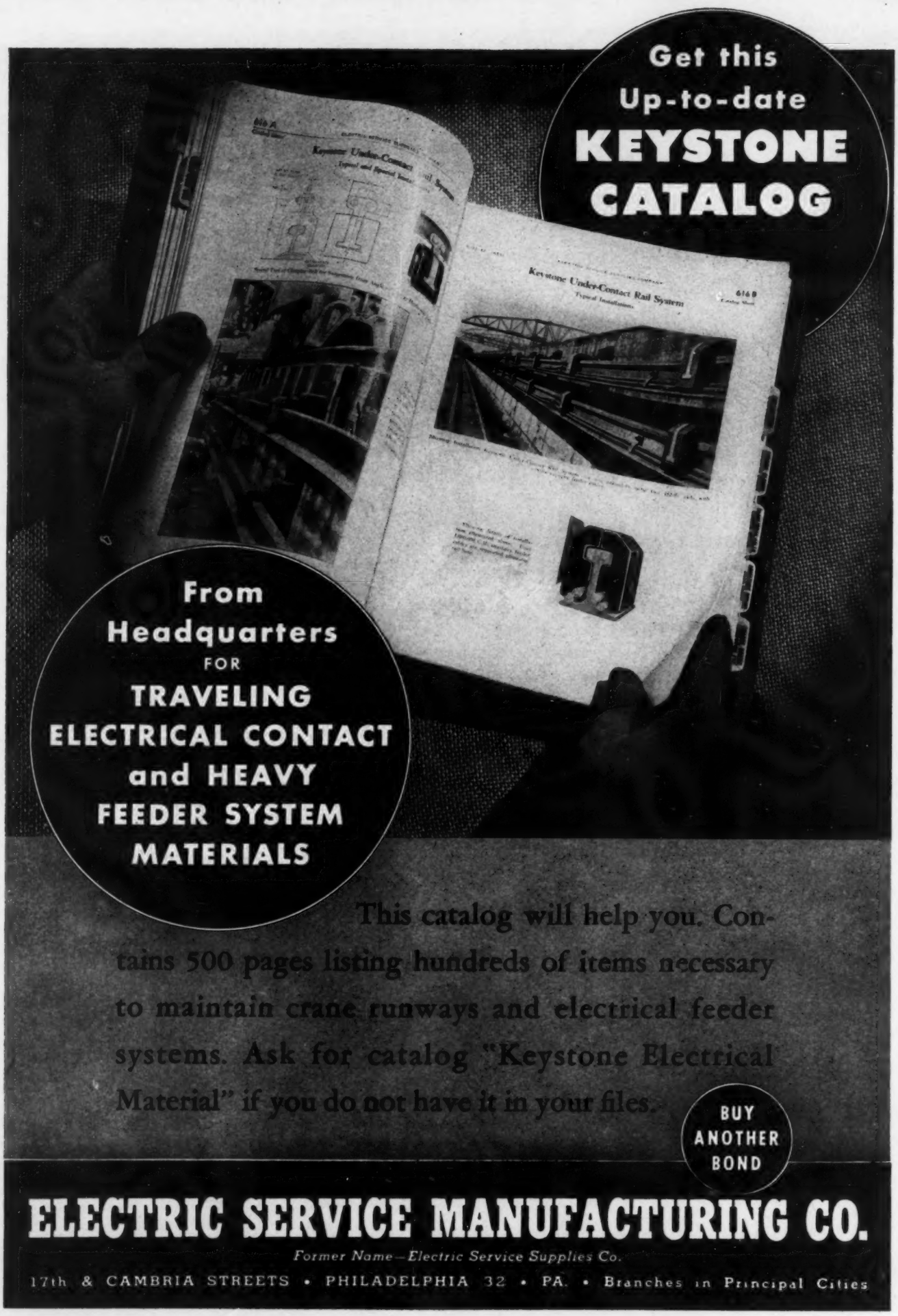
WASH-OIL PURIFIERS

Wash-oil purifiers are now improving the operation of twenty light-oil plants. A wash-oil purifier, as shown in the flow sheet, is a simple stripping column in which high-pressure indirect steam and sweep steam completely vaporize a portion of the partially debenzolized wash-oil, leaving a residue of muck for discard.



Wash-Oil Purifier Installation
Flow Diagram



This catalog will help you. Contains 500 pages listing hundreds of items necessary to maintain crane runways and electrical feeder systems. Ask for catalog "Keystone Electrical Material" if you do not have it in your files.

BUY
ANOTHER
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ELECTRIC SERVICE MANUFACTURING CO.

Former Name—Electric Service Supplies Co.

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AMERICAN INDUSTRY PRODUCES MORE, FASTER, BETTER—WITH BOWSER EXACT LIQUID CONTROL

How a Famous Manufacturer Protects Engines During the

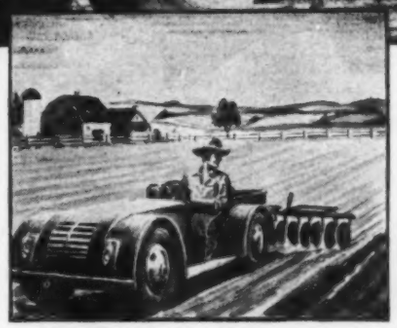
THREE MOST CRITICAL MINUTES OF THEIR LIVES

Engines made by Minneapolis-Moline Power Implement Company are doing some mighty essential work these days—such as powering the famous heavy-duty MM Jeeps and the many MM farm implements working to feed us and our Allies.

So every minute of an MM engine's years-long life is important. But most critical are the first three minutes of the initial run, for 70% of engine wear occurs during those minutes.

Now — enter Bowser Exact Liquid Control. Minneapolis-Moline protects its engines during the test run, including those three most dangerous minutes, with a Bowser Oil Circulating System that serves all test blocks.

Periodic losses from scored pistons and bearings have been completely eliminated. There's an important saving in oil, too. Previously, from 7 to 9 quarts were used in testing each engine. Now the oil loss is only about 60 gallons for each 300 engines tested.



Bowser Liquid Control, particularly Lubrication Systems, are virtually standard equipment in American steel mills. Over 90 per cent of all mills depend on Bowser lubrication for mill stands, pinion gear sets, reduction gears, turbines, turbo blowers and pumps, as well as for coolant filtration and circulation, the metering of fuel oil, etc.

Bowser installations are engineered to be integral parts of the mill. Bearing sizes and pressures, heats, etc., are all factors in the designing. That's why Bowser dominates in this field. Write for full information. BOWSER, INC., Fort Wayne 2, Ind.

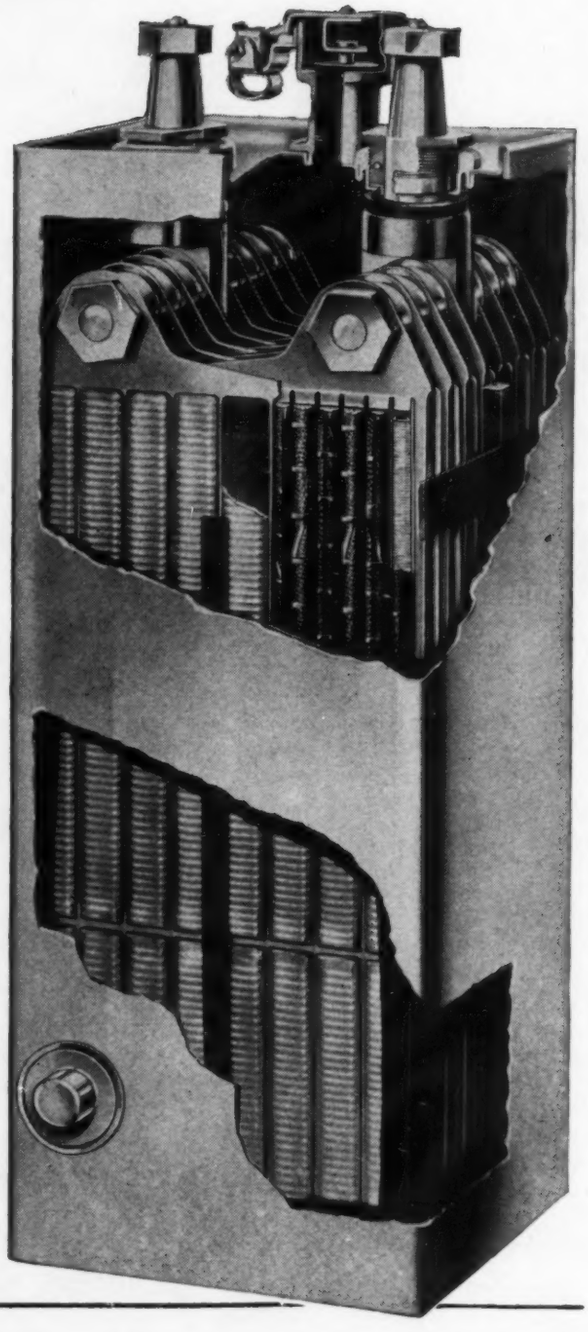
BUY WAR BONDS

Not only has Bowser's war production earned the Army-Navy E... Bowser equipment has helped earn it for scores of other companies.

BOWSER ESTABLISHED 1885

The Name That Means **Exact Control** *of Liquids*

MOST RUGGED OF ALL



Here is a cut-a-way view of a single cell of a typical Edison Alkaline Battery for operating electric trucks in industrial material-handling services. Note the ruggedness and precision of its construction. The container, cover, pole pieces and other structural parts are made of STEEL. Even the active materials are permanently locked in perforated STEEL tubes and pockets. These in turn are securely assembled into STEEL grids to form the positive and negative plates. The STEEL cover is welded onto the container. This cell construction is entirely different from that employed in other types of storage batteries . . . and every difference is an advantage to users of alkaline batteries in industrial trucks.

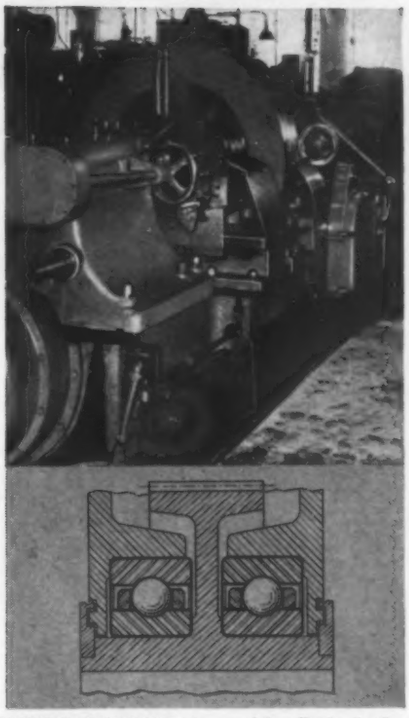
Because of their STEEL construction, they are by far the most rugged and durable of all batteries. When it comes to standing up under the shocks, vibration and hard usage in material-handling services, they have no equal. Alkaline batteries in trucks have fallen off loading platforms and docks, turned over, and even dropped down elevator shafts with little or no damage . . . and still delivered their full service life. The fact they can withstand such accidents, indicates the extra dependability that can be expected from them under more normal conditions. Their durable mechanical construction is also one of the principal reasons why alkaline batteries stay on the job and out of the repair shop, give longer life, and help cut material handling costs. *Edison Storage Battery Division of Thomas A. Edison, Incorporated, West Orange, N. J.*

Edison
ALKALINE-BATTERIES

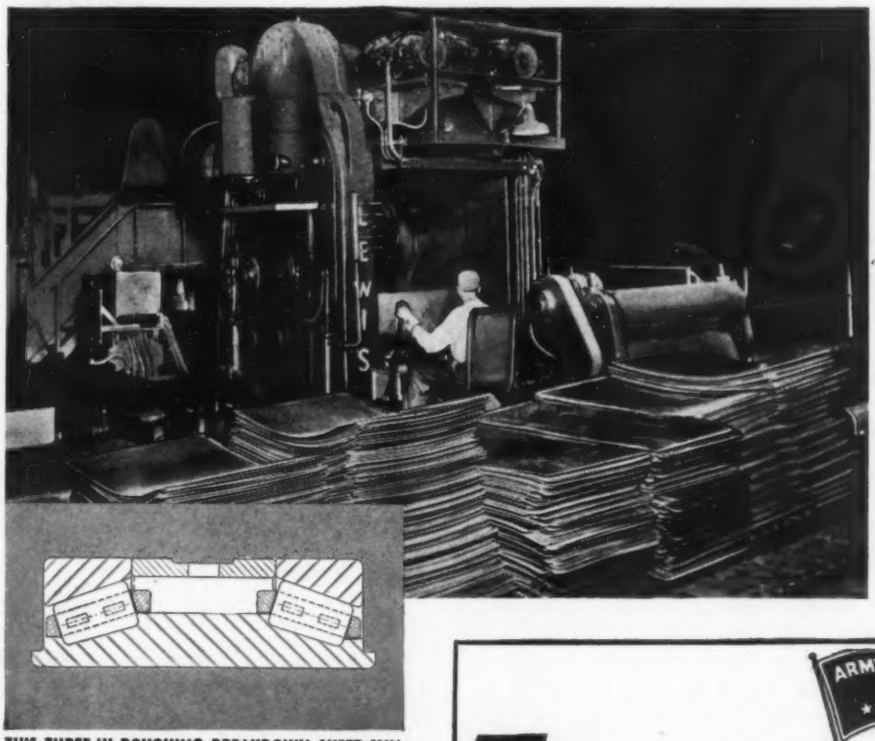
IN THE NEWS
WITH TORRINGTON BEARINGS

OFFICIAL PHOTO U. S. AIR FORCES

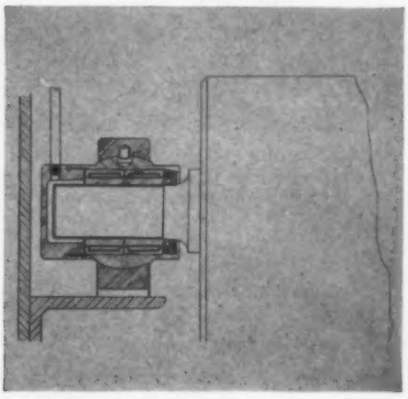
FLYING OVER 100 MILES AN HOUR this Army pilot of a Douglas B-23 tow plane is about to pick-up a 15-place glider. As the tow plane comes in, the arm of a pick-up device, manufactured by All American Aircraft, Inc., is lowered to catch the suspended tow line shown in the foreground. Torrington Ball Thrust Bearings were specified for installation in the mechanism of the pick-up, because of their capacity to withstand the severe and sudden shock loads encountered in the operation.



TURNING CRANKSHAFTS to precision limits is the important operation performed by this machine tool manufactured by the Hall Scott Motor Car Company. Due to high loads encountered in the center drive assembly, engineers specified the installation of two Torrington Ball Radial Bearings, as shown in the accompanying cross-section. The bearings have an outside diameter of 34″; an inside diameter of 27″, and are 3½″ wide.



THIS THREE-HI ROUGHING BREAKDOWN SHEET MILL, built by Lewis Foundry & Machine, is equipped with two-row tapered roller bearings, supplied by Torrington's Bantam Bearings Division, as shown in the accompanying cross-section. With each row employing 34 rollers, 1⅞″ long and 1-3/32″ in diameter, these bearings have a radial load capacity of 216,200 pounds; a thrust load capacity of 148,900 pounds at 100 R.P.M.



SUBMERGED in a bonderizing solution, the specially designed NCS Needle Bearings, shown in the accompanying cross-section, are sealed in a leak-tight housing equipped with a compressed air line to prevent the solution from reaching the bearing during operation. This is another example of Torrington's ability to adapt Needle Bearings to unusual applications. If you need counsel on standard or custom-built bearings, TURN TO TORRINGTON.

ARMY E NAVY

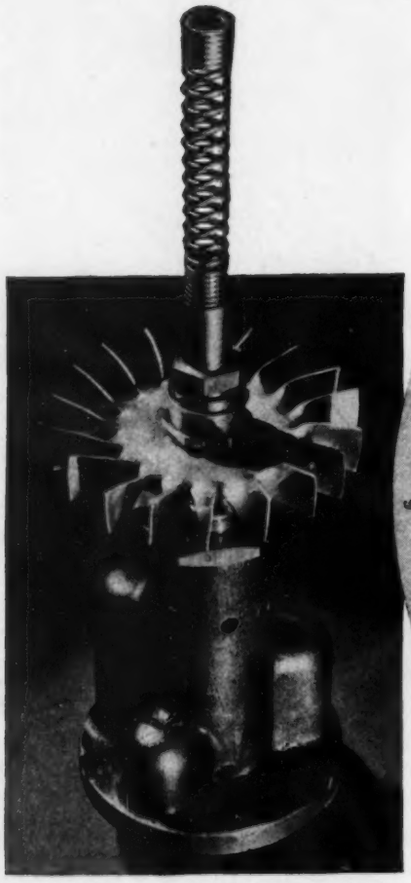
TORRINGTON BEARINGS

STRAIGHT ROLLER • TAPERED ROLLER • NEEDLE • BALL

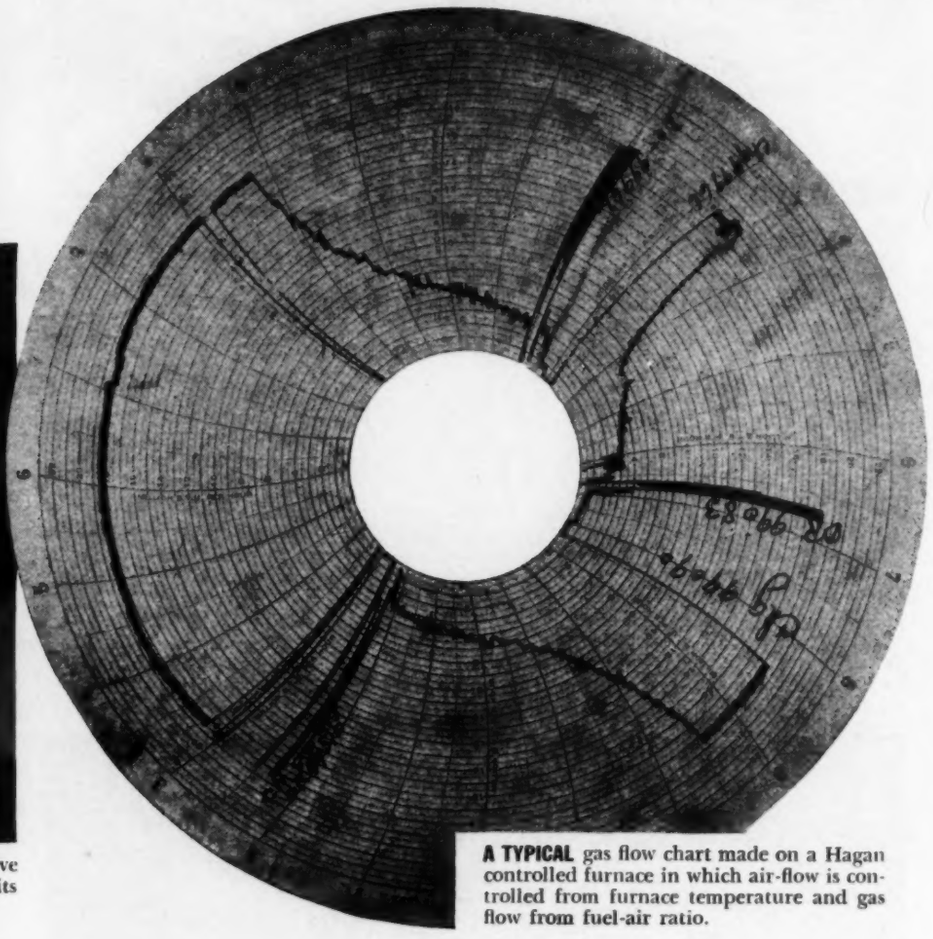
THE TORRINGTON COMPANY • BANTAM BEARINGS DIVISION

SOUTH BEND 21, INDIANA

What about *turn down* in steel mill furnaces?



HAGAN Spinning Pilot Valve—an exclusive development that gives Hagan Control its high sensitivity and fast response.



A TYPICAL gas flow chart made on a Hagan controlled furnace in which air-flow is controlled from furnace temperature and gas flow from fuel-air ratio.

THE present day steel mill furnace differs from its early predecessors in that it makes more general use of forced-air delivery, more extensive use of insulation and more efficient use of heat recovery apparatus. The effect of all these improvements on operations is to boost maximum firing rates and lower the quantity of fuel necessary to satisfy radiation and stack losses when the furnace and work are up to temperature.

This places an unusual burden on the air-fuel ratio regulating equipment. It must be rugged enough to operate at high differential pressures yet sensitive enough to maintain accurate fuel-air ratios at the lower firing rates.

The use of a sensitive diaphragm system in which the weight of all parts has been cancelled out of the weighing operation and a super-sensitive spinning-type pilot valve which is devoid of friction assure the user of Hagan apparatus reliable and accurate control at low as well as high firing rates.

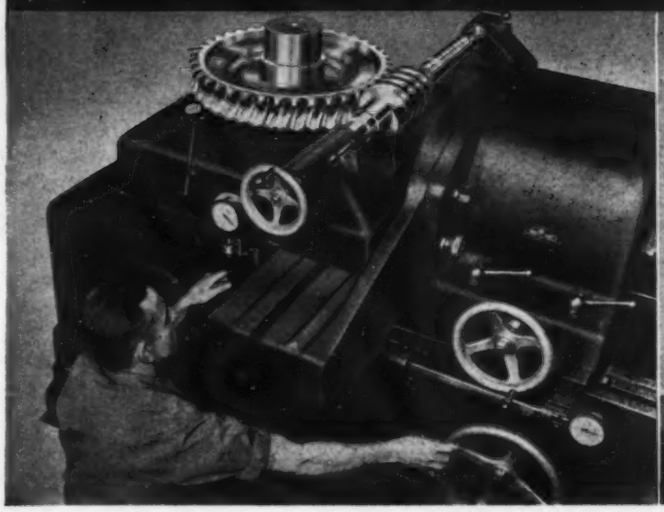
Write for complete information.

HAGAN CORPORATION · HAGAN BUILDING · PITTSBURGH 30, PA.

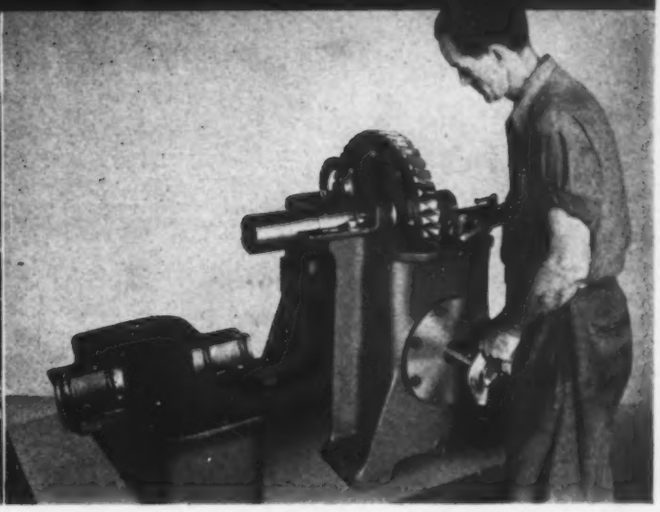
HAGAN *Automatic* COMBUSTION CONTROL

The pioneer . . . and still the leader

CHECKED for TOOTH CONTACT



1.—Checking tooth contact with worm and gear located at exact center distances, checked to within 1/10,000th of an inch.



2.— Checking tooth contact by means of "bearing blue" after assembly

BOTH *BEFORE and AFTER* ASSEMBLY

Before assembly, every De Laval Worm Gear is tested on the machine shown at the left, in which it is accurately mounted with the center line of the gear and the center line of the worm correctly spaced and at true right angles. Under these conditions the tooth contact is observed and the back lash accurately measured.

After assembly in the gear case, tooth contact is re-checked by means of bearing blue to assure correct adjustment. Such checking and holding center distances within close limits assures satisfactory operation of De Laval Worm Gear Speed Reducers, and facilitates installation when De Laval Worm and Gear sets are purchased for use in other machinery.

Specifications alone do not make a worm gear.

1147

TURBINES • HELICAL GEARS and WORM GEAR SPEED REDUCERS CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS and COMPRESSORS • IMO OIL PUMPS

WORM GEAR DIVISION

DE LAVAL

STEAM TURBINE COMPANY · TRENTON 2, NEW JERSEY

SALES OFFICES ATLANTA • BOSTON • CHARLOTTE • CHICAGO • CLEVELAND • DENVER DETROIT • DULUTH • EDMONTON • GREAT FALLS • HAVANA • HELENA • HOUSTON KANSAS CITY • LOS ANGELES • MONTREAL NEW ORLEANS • NEW YORK • PHILADELPHIA PITTSBURGH • ROCHESTER • ST. PAUL • SALT LAKE CITY • SAN FRANCISCO • SEATTLE TORONTO • TULSA • VANCOUVER • WASHINGTON, D. C. • WINNIPEG

NEWS SUPPLEMENT November, 1944

Equipment
Personnel
Literature

Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

REPUBLIC TO EXPAND PRODUCTION OF HIGH STRENGTH, LOW ALLOY STEELS

▲ Plans for a large expansion in its production and sale of high-strength, low-alloy steels to meet anticipated post-war demands for light-weight equipment in the transportation field were announced today by Republic Steel Corporation.

N. J. Clarke, vice president in charge of sales, stated that Republic has acquired license rights for the manufacture of "Cor-Ten" and "Aldecor" steels.

At the same time, Republic will continue to produce and market its own trademarked product, "Republic Double Strength Steel," which Republic developed for the trade some years ago.

"Cor-Ten," widely used for many years, is a patented steel produced by Carnegie-Illinois Steel Corporation, and other subsidiaries of U. S. Steel Corporation. "Aldecor," a comparatively recent product among the high-strength, low-alloy steels, was the result of research by Alloys Development Corporation, of Pittsburgh, and was developed by Republic Steel Corporation.

Mr. Clarke said, "The trend which began several years before the war toward the use of lighter but stronger steels by the transportation industry will accelerate sharply as soon as wartime restrictions on steel production are lifted.

"Republic believes that the addition of these two leading brands of high-strength steels will help to round out our range of products available for the construction of railroad freight and passenger cars, street cars, buses, trucks and trailers, and other similar applications in the transportation field."

NOT A COBBLE IN A CARLOAD . . . .

DAN REEBEL PHOTO

Roll designers of Republic Steel Corporation had a reunion at the annual meeting of the Association of Iron and Steel Engineers. Left to right, standing: Victor Williams, Dilworth-Porter Division; Earl Auer, Canton Works; J. Victor Halldin, Buffalo District; Charles Barrett, Chicago D. P. C. Plant; J. A. Lafferty, Warren District; Peter Reynolds, Massillon Works. Sitting: John Wessman, Cleveland general office; John Hindmarch, Chicago District; George Pimlott, Cleveland District; and Paul Frey, Youngstown District.

NEW UNIVERSAL CHUCK WILL FIT ALL LATHES

▲ The Ideal Commutator Dresser Company, 1045 Park Avenue, Sycamore, Illinois announce a new universal 3-jaw chuck to supplement their popular line of machine tool accessories.

This new chuck is inexpensive, yet precision made to assure accurate turning. The body is of high grade, fine grain, high tensile strength semi-steel. Ample resistance to shock, load and unusual stress is provided by rib construction.

No expense has been spared in special tooling required to make the threads of the scroll as accurate as possible. The scroll is made of alloy steel and has heavy proportions to assure true turning and long life.

Two sets of jaws are furnished, one for internal and the other for external work. The jaws are made of specially treated alloy steel to give toughness and strength. If one jaw is damaged, it can be readily replaced.

At present, the Ideal chuck is

RUSSIA ORDERS Fitch Recuperators

For years Russia has tried to improve its manufacturing methods . . . to advance its industrial productivity . . . by using the best American engineering skill and the best American equipment.

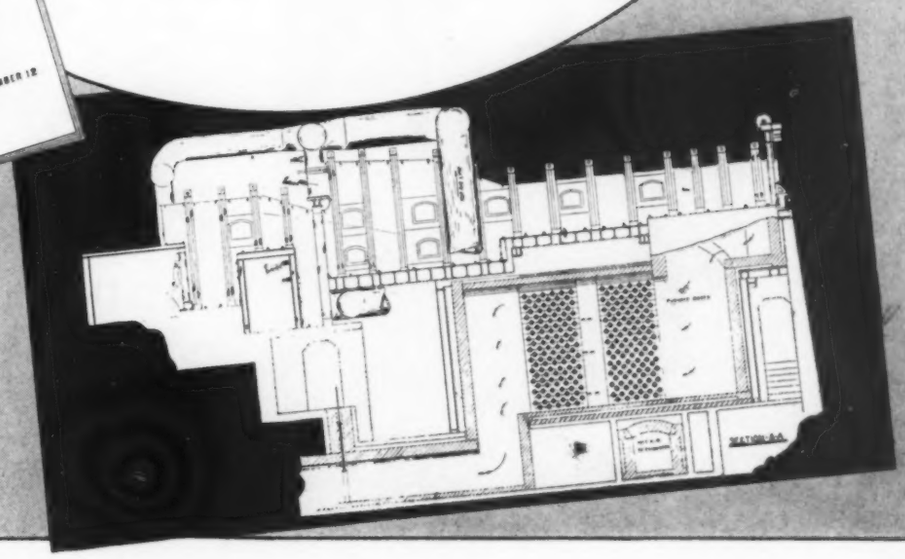
We feel proud that the foremost engineering minds in Soviet Russia chose our Fitch Recuperators for use in her vast steel mills.

Fitch Recuperators last much longer. When eventually they do need repairs, Fitch Recuperators are so easily accessible, repairs can be made in several hours by simply replacing a few injured tubes.

We do not build furnaces—see your furnace builder.

FITCH *Recuperators*

PLAINFIELD, NEW JERSEY, U. S. A.



Write TODAY
FOR BOOKLET No. 12

PHILCO IS READY TO REDUCE YOUR POST-WAR BATTERY COSTS

THE NEW "PHILCO THIRTY" *Gives 30% Longer Life*

Storage battery purchases made from now on, are essentially a post-war investment. So be sure to keep posted on this sensational post-war Philco Battery development—the new Philco Thirty that gives 30% longer life! Here, at last, is a really revolutionary new long-life construction—employing a brand new principle of FABRICATED INSULATION!* It's available now in certain types and limited quantities. And as rapidly as war time restrictions are eased, Philco will make it possible for every user of electric industrial trucks to share in the new economy and more efficient operation of this great new battery. Write today for information. **Patent Applied for*

PHILCO CORPORATION, STORAGE BATTERY DIVISION
TRENTON 7, NEW JERSEY

Specify

PHILCO
INDUSTRIAL TRUCK BATTERIES

FOR 30 YEARS A LEADER IN INDUSTRIAL STORAGE BATTERY DEVELOPMENT

available in the 5 in. size only. A mounting adapter is furnished with each chuck so that the chuck may be accurately fitted to the particular lathe on which it is to be used.

PATENT GRANTED FOR COLD FINISHED STEEL

▲ LaSalle Steel Company has announced the granting of a patent covering such steels as are sold under the trade name Stressproof.

The patent, U. S. 2,320,040, covers the method as well as resultant products. This new method of cold finished steel bar production consists of a combination of cold finishing and thermal treatments to obtain uniform and dependable strengths and straightness, as well as other advantages.

While the new method can be used in the production of a wide range of steels, the company reports that the process is most applicable to the modified pearlitic manganese steels.

Over 50,000 tons of steel made by this patented method have been used by industry.

810,000 KVA IN NEW GENERATORS FOR RUSSIA

▲ International General Electric will supply nine 90,000 kva generators for the U. S. S. R. Dnieprostroi hydroelectric plant, according to an announcement by the company. The huge generators, already in construction at General Electric's Schenectady Works, will give the famous plant a 15 per cent greater output capacity than it had originally.

The new generators will replace those partially destroyed by the Russians when they retreated before the Germans in 1941. The original generators for the plant, which was completed in 1933, were rated 77,500 kva and 88.2 rpm. The new 90,000 kva units will operate at 83.3 rpm. This decrease in speed, coupled with the increase in kva, results in an equivalent increase in size of 21 per cent. They will be the largest generators in diameter and total weight ever built.

Hydraulic turbines for the station are being built by the Newport News Shipbuilding and Dry Dock Company. Each of these waterwheels will be capable of developing 100,000 hp.

Financing of the machines will be by the Soviet Union and not by lend-lease, according to an announcement by the War Production Board. The WPB announcement also stated that no fixed delivery date would be promised for the machines and "manufacture would not be allowed to interfere with the production of war supplies or equipment needed for essential civilian production."

The Dnieprostroi dam, a reinforced concrete structure across the Dnieper River at Zaporozhe, was blown up by the Russians in August, 1941, when the Nazis invaded that section of the country. The Germans spent more than a year in repairing the dam and eventually got some power from the station. But late in 1943 when the Russians drove the invaders out of the Ukraine, the Germans completed destruction of the station and the dam.

BETTER PRODUCT CONTROL is possible with Hays Draft or Pressure Recorders which are a positive guide to balanced draft conditions in soaking pits, open hearths, slab mills, annealing and other furnaces. They eliminate guesswork, save man power and reduce rejects to the minimum. They are a real help in the all-out effort for bigger and better steel production.

The ten-inch, 24 hour charts give a permanent record of day in and day out performance of every furnace. Two draft values, two pressure values, two differential values or any combination of two of these three values may be recorded. Or temperature may be included if desired and mercury switches may be provided to operate an alarm or a power unit to open and close a damper, etc.

Any way you look at it, the Hays Series OT Draft Recorder is a Guard over furnace operation and merits your investigation. ***Write for Bulletin 39-232.***

The HAYS CORPORATION
SINCE 1901 COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A

G-E DELTABESTON CABLE

Heat, the most destructive agent of electrical circuits, can bake out the insulation on your wiring, raise havoc with your motors and cause power failures at the most inopportune time. That's why mill operators install Deltabeston Asbestos-insulated Power Cables. Then they know their power, lighting and control circuits are fully protected even in scorching heat such as around soaking pits, boiler rooms, kilns and in other hot locations. Next time rewire with Deltabeston and be safe.

Deltabeston Power Cables Types AVA and AVL are ideal for installations where constant high temperatures prevail. Deltabeston is insulated with asbestos purified by an exclusive process which provides great heat resistance. The asbestos is felted or taped to the flexible copper to produce a very tight bond. AVA and AVL Cables are braided with a heavy asbestos to protect the insulation. The braid is then impregnated with a compound to provide the cable with high resistance to heat and moisture.

Regardless of the cable application, if heat is a problem, there's a Deltabeston product to fit your needs. For additional information write to Section Y1142-31, Appliance and Merchandise Dept., General Electric Company, Bridgeport, Conn.

Hear the General Electric radio programs: "The G-E All Girl Orchestra" Sunday 10 P.M. EWT, NBC. "The World Today" news every weekday 6:45 P.M. EWT, CBS.

BUY WAR BONDS AND KEEP THEM

GENERAL ELECTRIC

ALLOY ADDITIONS WILL IMPROVE CAST IRON

▲ Two "stabilizing inoculants" for cast iron, which provides all the well-known benefits of chromium in iron without the usual increase in depth of chill, have been developed by Electro Metallurgical Company, a unit of Union Carbide and Carbon Corporation. They are known as "CMSZ" alloys 4 and 5. These new ladle-addition alloys are a handy means of adding both chromium and strong graphitizing agents.

Proper use of one of these "CMSZ" alloys will result in noticeable improvement in the physical properties of a cast iron. Chief among the benefits derived are the increased hardness and wear resistance obtained from the addition of chromium; yet these effects are achieved with little or no loss in machinability. Even when the chromium content is as high as 2 per cent the iron is machinable. The alloys also improve the tensile and transverse strength of a cast iron; they greatly reduce the tendency to growth; and they impart higher resistance to oxidation and to the annealing effect of elevated temperatures.

In most irons, worthwhile improvement is obtained if enough "CMSZ" alloy is introduced to add 0.35 per cent chromium. However, the correct grade and amount of alloy to use will depend principally on the composition of the base iron and the results desired. Further information on "CM SZ" alloys is obtainable from Electro Metallurgical Company, 30 East 42nd Street, New York 17, N. Y.

COMBUSTION SURVEY OFFERED TO INDUSTRY

▲ A service recently announced by Cities Service Oil Company offers without charge or obligation, a complete combustion control test made in your own plant. Using a new instrument developed by Cities Service and thoroughly tested on all types of fuel and combustion equipment, such tests have been found to reveal possibilities of fuel conservation, increase quantity and quality of product, and reduce furnace maintenance. This service is available in Cities Service marketing territory east of the Rocky Mountains. For further details write Cities Service Oil Company, 919 N. Michigan Avenue, Chicago 11, Illinois.

ALLOY POWDER AIDS IN TIPPING TOOLS

▲ Carbide and high speed steel tipped tools are generally tipped by preplacing a strip of brazing alloy, together with a sufficient amount of flux, between the tip and the shank. The assembly is then placed in a furnace, or heated with an induction coil. This procedure, however, is sometimes objectionable, as the foil may become tarnished or oxidized and then require a temperature considerably above its own melting point to flow freely. Experiments have proved that the use of alloys in powder form would present definite advantages over the use of silver brazing alloys in the form of foil.

There are, therefore, two outstanding silver-copper and one copper alloy used for tipping tungsten carbide and high speed steel tools now available in a fine powder. These alloys are very economical in use since the required flux is mixed right in with the powdered alloy. This eliminates any waste of flux during preparation. Then, too, the powder does not require the special handling necessary for cutting the foil into small pieces for exact preplacing.

These alloys are the product of the Eutectic Welding Alloys Company. They are known as

EutecRod 1800 (lowest melting) for H. S. S. 940-1140 F.

EutecRod 1601 (high tensile) for tungsten carbide 1020-1250 F.

EutecRod 16 (heat resistant, high tensile), for tungsten carbide 1300-1750 F (furnace temp.).

After the customary degreasing and grinding, the powdered alloy is spread on the surfaces to be joined, and the tungsten carbide tip is placed on top. The assembly is then heated until the alloy melts. The metal flows freely at a very slight increase in temperature above the melting point since the weld metal is pulverized. Oxidation of the tungsten carbide is prevented, as each particle of molten alloy immediately "tins" and adheres to the surfaces being joined.

Many leading manufacturers of tipped tools have already adopted this new process which should be of interest to all tool users.

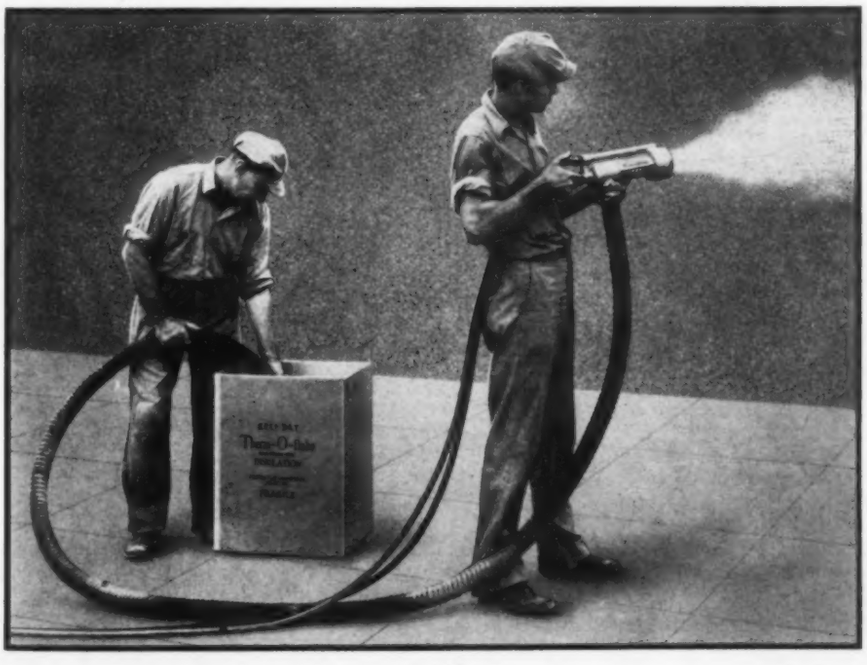
GUN SAVES MANHOURS IN APPLYING COAT OF INSULATION TO FURNACE WALLS

▲ Open hearth operators will be interested in a new gun designed to speed up the sealing and insulating of open hearth walls and bulkheads.

This gun syphons dry Therm-O-Flake insulation direct from the shipping carton, mixes with water and sprays to the refractory wall in one operation. Premixing is eliminated. Application is 6 to 8 times faster than by manual methods.

The Therm-O-Flake gun operates on standard air and water pressures. It weights but 4 pounds and can be moved about as easily as a man can walk. Units are shipped complete with 15 foot sections of air, water and vacuum hose and all necessary valves and fittings. Complete information may be had by writing Illinois Clay Products Company, 608 S. Dearborn Street, Chicago, Illinois.

Mixing the dry Therm-O-Flake insulation with water as it sprays, this gun operates on standard air and water pressures.



NEW PROTECTIVE LOTIONS FOR SKIN

▲ Mine Safety Appliances Company has announced the addition of Fend-U, Fend-F, and Fend-PC to its Fend group of protective creams and lotions.

Fend-U is a lotion which forms a semi-water repelling barrier on the worker's skin against all types of cutting and oils and cooling compounds, kerosene, carbon tetrachloride, tetrachlorethylene, benzol, other solvents and degreasers, mild acid and mild alkaline solutions, alcohols, and acetates.

Fend-F is a water soluble heavy duty lotion which helps guard against dermatosis from aluminum, magnesium and zinc dusts; forms an effective barrier against Fiberglas, sharp particles, fruit and vegetable fuzz, chlorinated solvents.

Fend-PC helps reduce nervous perspiration where this is the cause of skin irritation — thus helping to prevent rusting of polished metal surfaces through contact with skin moisture. It is a water soluble cream which protects the skin against dust-borne irritants, grime, grease, dirt.

Fend creams and lotions, according to Mine Safety, form a protective physical barrier on the skin against scores of irritants encountered in industry. They are simply rubbed onto the exposed skin, before work, and are easily removed with mild soap and warm water at work's end. There are now nine Fend types, including the three new additions. Descriptive literature, including a detailed application chart, is available on request from Mine Safety Appliances Company, Braddock, Thomas and Meade Streets, Pittsburgh 8, Pennsylvania.

BUILT BY MORGAN *Engineering*

ONE OF TWO MORGAN 200-TON, 83'0" SPAN UNIVERSAL TYPE INGOT STRIPPERS IN A MID-WESTERN ELECTRIC FURNACE STEEL PLANT

The Stripper as illustrated will perform three distinct stripping operations without change in the stripping unit.

(1) Strip small-end-up or standard ingots.
(2) Strip big-end-up hot top ingots.
(3) Break small-end-up ingots loose from stools.

With this type of Stripper it is possible to strip a mixed heat without lost time.

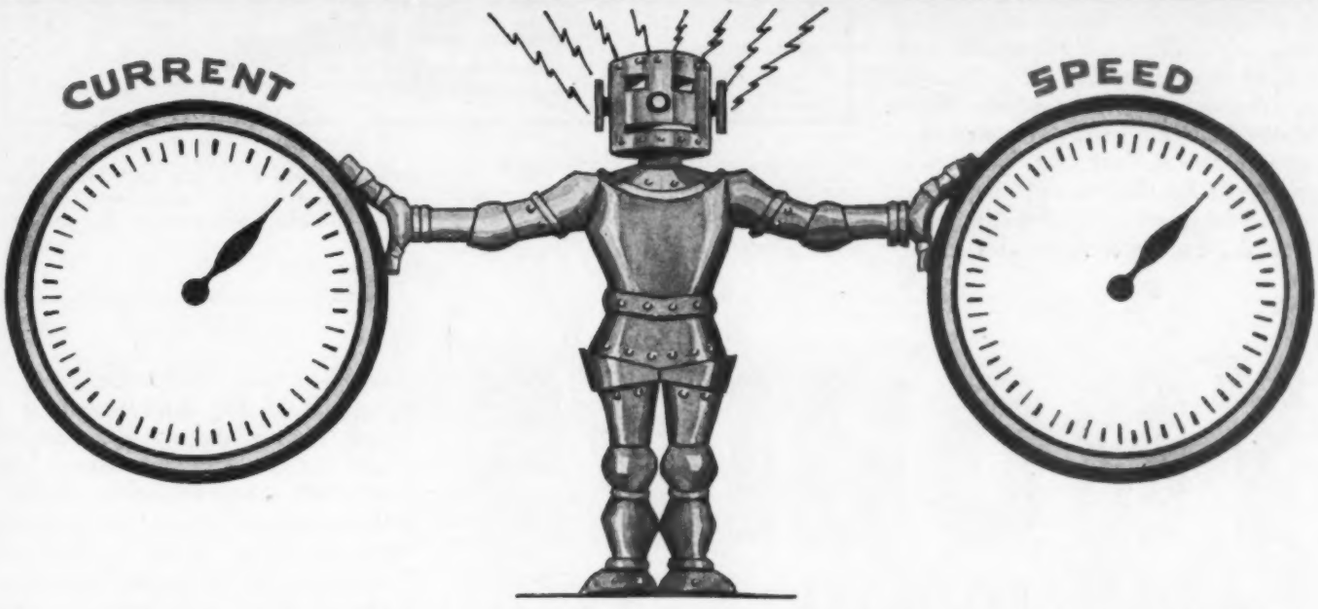
Additional Morgan equipment in this plant includes: Two 300-Ton, 65'0" Span Pouring Cranes. Three 150-Ton, 65'0" Span Pouring Cranes. Two 150-Ton, 80'3" Span Hot Metal Charging Cranes.

THE MORGAN ENGINEERING CO.

ALLIANCE, OHIO. 1420 Oliver Building, Pittsburgh

DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS • ELECTRIC
CHARGING MACHINES • INGOT STRIPPING MACHINES • SOAKING PIT CRANES • ELECTRIC WELDED
FABRICATION • LADLE CRANES • STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

CLARKTRONIC REGULATORS



¶ Clarktronic Regulators are Electronic Devices designed to maintain and control the relation of speed, current or voltage to a basic operation such as speed.

¶ Clarktronic Regulators provide performance that existing electric regulating devices cannot supply.

¶ A variety of applications, where extreme accuracy is needed, are possible. Used at present to control current vs Speed, other applications are to control speed, temperature, light output, voltage, and allied functions.

¶ Clarktronic Regulators are simple in construction, with a minimum of wearing parts, thus presenting no maintenance problem. They are practically instantaneous in response, and extremely accurate in performance.

¶ For further information, please forward inquiries with complete application data, to the address below.

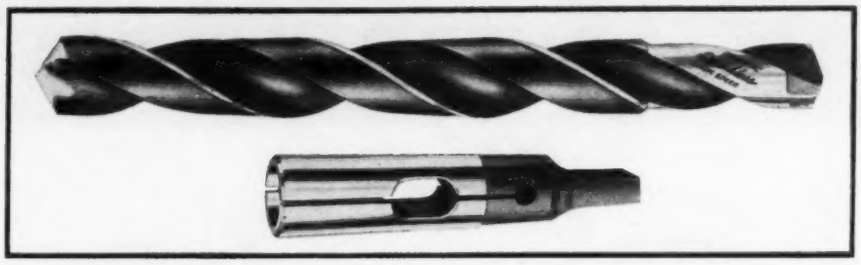
CONTINUE TO ROLL WITH CLARK CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152ND ST. CLEVELAND, 10, OHIO

ANNOUNCE DRILLS MADE BY NOVEL PROCESS

▲ Just announced by Republic Drill and Tool Company, Chicago, Illinois, is the new "Shankless" high speed drill, a development originated and perfected by Raymond R. Rausch, general superintendent of the Ford Motor Company, where the drill has been in use for six years. The new drill has a continuous flute produced by roll-forging and hot twisting, and it is driven by a removable taper shank. Advantages claimed for the new drill include lower cost, a greater usable portion of the flutes, and greater strength because of a heavy web.



After six years of use at Ford Motor Company, this shankless drill is available to industry in general.

There are two disadvantages: It is necessary to buy and maintain a supply of drill drivers (the removable taper shank), and because of the heavy web, it is necessary to thin the web each time the drill is resharpened. Six years of use at the Ford Motor Company, however, indicate that these disadvantages are far outweighed by the advantages offered. The shankless drill is made in 135 sizes, from ¼ in. to 2 in. diameter.

For further information, write Republic Drill and Tool Company, 322 S. Green Street, Chicago 7, Illinois.

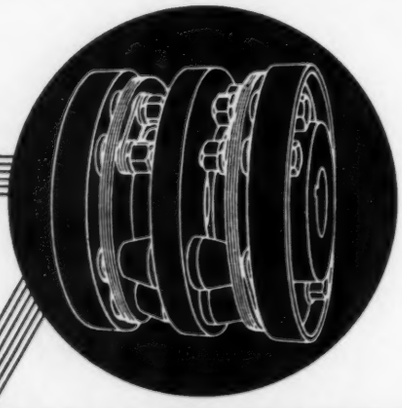
HOIST HOOK DESIGN HAS SAFETY FEATURES

▲ A heavy duty hoist hook that is just about the last word in safety has appeared on the market under patent No. 2,359,557. The invention of an active engineer, this hoist hook safely handles loads up to 200 tons.

Robert Hoffman, the inventor, while engaged on such projects as the North Island Naval Base at San Diego, Pan-American Highway, etc., experimented with many types and designs of hoist hooks. His goal was a hook which would be proof against breakage, slippage, work stoppages and accidents to life and property. He firmly believes that this goal is reached in the new ACLC hoist hook and leading American engineers agree with him.

A single No. 2 ACLC safety hoist hook weighs only 9½ lb, yet has a guaranteed capacity of 10 tons and has withstood without any ill effects a Columbia University laboratory proof load test of 60,000 lb. Because it is carefully engineered for the pur-

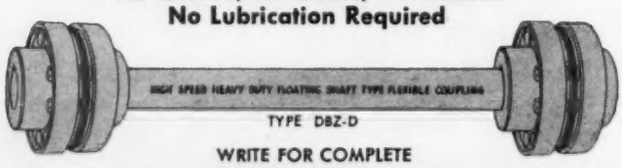
THOMAS
Flexible COUPLINGS



TYPE DBZ
TYPE DSM
TYPE CM
TYPE AM
TYPE MT
TYPE SS

Eliminate BACKLASH, FRICTION, WEAR AND CROSS-PULL
the four destructive evils of other types and makes of couplings that prevent a permanent care-free installation.

The Thomas All-Metal Coupling has:
No Chains, No Gears, No Rubber.
No Lubrication Required



TYPE DBZ-D

WRITE FOR COMPLETE ENGINEERING CATALOG

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA

pose the ACLC hoist hook keeps hoist and load in true alignment, while the patented shoulder and lip eliminates load slippage and hook straightening. Even should the heavy pin shear, the weight of the load would continue to hold on the safety shoulders and lips. Although originally planned and made solely for use on his own assignments, Mr. Hoffman has arranged to have his hook manufactured and distributed by the American Chain Ladder Company, Inc., 151 East 50th Street, New York City.

REEL BALANCES AND HOLDS SMALL TOOLS

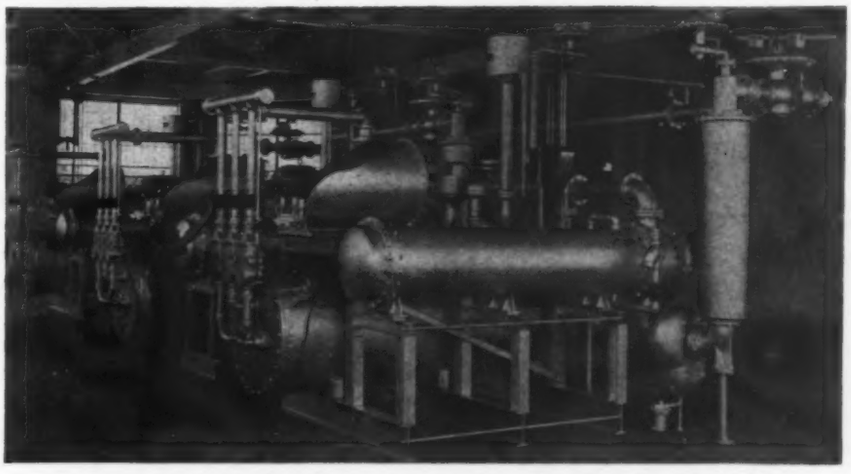
▲ The Appleton Electric Company, 1701-41 Wellington Avenue, Chicago 13, Illinois, manufacturers of Unilets, Reelites and other electrical products, announce the Retract-o-Reel, which is a light-weight all cast balancing reel used for supporting portable tools, as well as air and electrical devices weighing up to 10 pounds. Reels support light-weight drills, screw-drivers, assembly tools, etc., directly over production line while operator is otherwise engaged. When operator has finished using a tool, the Retract-o-Reel lifts tool up over work and out of the way. Reels have adjustable cable clamps which hold tool in exact position for easy reach and access. The Retract-o-Reel eliminates lost motion and affords highest efficiency on production lines.

REFRACTORY USED IN TUYERES AND COOLERS

▲ Recently new types of safety tuyeres and coolers have been developed for blast furnace use by S. P. Kinney Engineers.

The Fleisch refractory safety tuyere contains refractory packing in the back part of the cooling section. In the development of this type of tuyere, it was found that only the nose section of the tuyere needs water cooling, and therefore the back of tuyere may be packed with refractory. The presence of refractory packing in the rear portion of the tuyere retards, or prevents, molten metal from cutting through the back end of the tuyere and causing a furnace stop. This refractory packing has been found capable of holding the molten slag and metal for a considerable time after the tuyere has been badly burned. The operator therefore may wait for a tuyere change until a convenient stop occurs. Tuyeres of this type have been found to give long life in service and the safety feature is of considerable advantage in operation, according to the manufacturer.

The refractory lined safety cooler is made of bronze, similar to other coolers, except that on the inside and the lower portion of the cooler a refractory lining has been set in. This refractory lining extends for about one-third of the way around the inside of the cooler and consists of ordinary fire brick in the form of splits laid into the cooler. In case molten iron runs back through the tuyere and blow pipe, and subsequently cuts the blow pipe, this molten iron will not cut the cooler. The refractory lining provides protection to the cooler and has been found to eliminate lost time due to the cutting and subsequent changing of coolers. For further details address S. P. Kinney Engineers, 233 Oliver Avenue, Pittsburgh, Pa.



Three 15,000 CFH Kemp Atmos-Gas Producers for a Leading Steel Mill

Specify "The Kemp Atmos-Gas Producer for Controlled Metallurgical Atmospheres"

The Kemp Atmos-Gas Producer is available in Standard sizes ranging from 1,000 to 50,000 CFH. Combusting ordinary fuel gases, one basic design (with suitable modifications) provides a proper, variable and controlled atmosphere for such diverse heat-treating operations as:

HIGH CARBON AND ALLOY STEELS
- Annealing
- Bright annealing
- Bright hardening
- Tempering and hardening
- Reduction and sintering
- Normalizing

STEELS
- Annealing
- Bright annealing
- Tempering and hardening
- Gas carburizing
- Furnace brazing
- Short cycle hardening
- Reduction and sintering
- Normalizing

BRASS
- Clean annealing
- Furnace brazing
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- Bright annealing
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- Silver soldering

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Adsorptive Dryers for Air and Gas
The Industrial Carburetor for premixing gases
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A complete line of Industrial Burners, and Fire Checks

Address The C. M. Kemp Mfg. Co. 405 E. Oliver St., Baltimore-2, Maryland

KEMP of BALTIMORE

New Literature

▲ To aid heat treaters in the safe handling of anhydrous ammonia, Pennsylvania Salt Manufacturing Company, Widener Building, Philadelphia, Pennsylvania, has just issued a bulletin "Heat Treating with Ammonia." Although discussing only such operating details as bear directly on ammonia, the booklet gives considerable information on the properties of anhydrous ammonia and on recommended methods for handling and using the gas. Copies of the booklet are available upon request.

▲ In a new bulletin, "H-W Refractories," Harbison-Walker Refractories Company, Pittsburgh, Pennsylvania, sets forth information concerning refractories regularly produced at their Kentucky-Southern Ohio district plants from high quality flint and plastic clays produced in the company's own mines. The folder also contains information concerning Harbison-Walker insulating firebrick and high temperature bonding mortars.

▲ Just published by the Vulcan Iron Works, Wilkes-Barre, Pennsylvania, bulletin No. A-394 features tank-type steam locomotives manufactured by the company. Well illustrated throughout, the bulletin also shows larger tender-type steam locomotives, diesel, gasoline and diesel-electric models produced. Also included are several pages of data useful in determining locomotive capacity, rail size, etc. A copy of the bulletin may be had upon request.

▲ Under the title "Graphitar," a United States Graphite Company booklet sets forth a wide variety of products made from carbon-graphite. The material which is mechanically strong yet very light in weight, has self-lubricating properties and is strongly resistant to chemical attack. It will not warp and shows practically no expansion or contraction with extreme changes in temperature. Manufactured in several basic grades, Garphitar has been applied as rotary pump blades, rotary pressure joint seals, turbine packing rings, pump and coupling seals, metal-backed bearings, piston rings, metering discs, sump pump bearings and many other uses. Copies of the booklet may be had by writing the United States Graphite Company, Saginaw, Michigan.

▲ An unusual booklet recently published by the Aetna-Standard Engineering Company, Youngstown, Ohio, combines the company's 1944 annual financial report with a well illustrated catalog section showing Aetna-Standard's facilities for designing and building its broad line of mill and factory equipment as well as for production of war goods.

▲ A new 8-page bulletin, G-448, illustrates and describes in detail the speed indicating and speed recording tachometers offered as accessories for the Reeves variable speed control units — the Transmission, the Vari-Speed Motor Pulley and the Motodrive. Thus, visible indication of exact speed may be had with installations of the variable speed drives. A copy of the bulletin may be obtained by writing the Reeves Pulley Company, Columbus, Indiana.

▲ A new enlarged edition of its thermocouple data book and catalog has been issued by Wheelco Instruments Company, Harrison and Peoria Sts., Chicago 7, Illinois. Designated bulletin S2-5 and containing 40 pages, the catalog describes products, gives prices and offers recommendations for thermocouple users. It gives data helpful in selection of thermocouples, lead wire, protecting tubes, heads and insulators. Also included are millivolt tables on the various types of thermocouples, temperature conversion tables, tables on wire resistance and on pipe and wire sizes, and a fraction-decimal equivalent chart.

▲ A method for holding constant the temperature of electrically heated salt pots, by means of a reliable control system which readjusts promptly the rate of heat input at the first indication of a temperature change, is described in a new 8-page bulletin just issued by Leeds and Northrup Company.

The bulletin describes equipment which is suitable for either internally or externally heated salt pots: a Rayotube detector and a duration-adjusting type of Micromax electric control. Together they comprise a system developed to provide the same close regulation which M. E. C. control formerly made available only to those fired by fuel.

Where this control is used, it is claimed that bath temperature is held uniform during heat treat and is brought back quickly to control point each time new work is added. Overshooting is prevented, rejects are reduced and more and better work results.

This control system is said to be easy to operate, to maintain and to install. Once the controller has been set to the desired operating temperature, control is automatic. The Rayotube, which sights downward into a closed-end tube immersed in the bath, or simply sights directly on the surface of the bath, holds its calibration indefinitely . . . needs no replacement. The Micromax controller and M. E. C. control unit can be shipped mounted on a factory-wired panel. No tapped transformer is required.

A copy of this illustrated publication is available to anyone interested. Write for bulletin N-33B-621(1), Leeds and Northrup Company, 4934 Stenton Avenue, Philadelphia 44, Pennsylvania.

▲ To acquaint grinding wheel users with the newly announced standard markings for identifying grinding wheels and other bonded abrasives, The Carborundum Company has prepared Grinding Facts, a 136 page reference book on grinding which includes a complete explanation of the new marking symbols; a comprehensive schedule of grading recommendations for general, toolroom, diamond wheel, and thread grinding; a description of each common type of grinding; safety rules; and a table of useful speeds.

For a free copy of Grinding Facts, write on your business or company letterhead to The Carborundum Company, Niagara Falls, New York.

▲ "Keeping Air Circuit Breakers in Trim" is the title of bulletin No. 4408, recently published by the I-T-E Circuit Breaker Company. An air circuit breaker, like any other machine, performs better and lasts longer when given a reasonable amount of care. "Breaker won't stay closed?"—

More Horsepower for your Dollar!

With the new Speedaire Fan-Cooled Reduction Unit, horsepower works *for* you instead of going to waste. Heat generated during operation is continually scoured off the outer surfaces of the oil reservoir by a high-velocity air stream.

Speedaire stays cool—delivers up to twice the capacity of standard worm units of equal frame size at usual motor speeds—thus giving you *more horsepower for your dollar.*

Install modern Speedaire Units on *your* new machines and you insure the dependable performance of your equipment through the years ahead. The Cleveland Worm & Gear Company, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Carporation, Centralized Systems of Lubrication
In Canada: PEACOCK BROTHERS LIMITED

Cleveland **SPEEDAIRE** *Worm Gear Reduction Units*
FAN COOLED

"Contact impression? What's that?" — "How much oil in the time-delay cups?" — are only a few of the questions answered. This new eight page booklet, written to help men who are responsible for air circuit breakers, may be obtained by writing to The I-T-E Circuit Breaker Company, 19th and Hamilton Streets, Philadelphia 30, Pennsylvania.

▲ Just off the press is a new bulletin describing the new Askania power unit. This equipment has been designed to extend the range of uses for air operated controllers. It is primarily actuated from the air loading pressure of an air operated controller and employs hydraulic operation to control heavy valves and dampers.

A copy of bulletin 120 may be had by writing the Askania Regulator Company, 1603 S. Michigan Avenue, Chicago 16, Illinois.

▲ Crucible Manufacturers' Association, whose members are engaged in manufacturing crucibles for melting nonferrous castings, such as brass, bronze, nickel, aluminum, and other metals and alloys, has just released for general distribution a pamphlet entitled Crucible Melters' Handbook, a treatise on crucible furnaces and on the storing, handling and use of crucibles.

The pamphlet is illustrated with many actual scenes of crucible installations and contains a table of standard sizes of crucibles and their dimensions; a table of melting points of various metals; a table of the composition of steam or red brass alloys; and a tabulation of the approximate composition and physical properties of aluminum sand casting alloys.

Copies of the handbook are available from the Crucible Manufacturers' Association, 90 West Street, New York 6, New York.

▲The Robert H. Clark Company, manufacturers of Clark cutters, announces the release of a new adjustable cutting tool catalog. Printed in two colors and profusely illustrated with diagrams and photos of actual operations, the catalog contains complete specifications and prices, as well as detailed descriptions of the entire line of Clark adjustable cutting tools.

According to the company, their unique principle of adjustability applied to cutting tools which has proven so valuable in war production is fully explained, and the adaptability of these tools to reconversion programs is readily seen.

The new catalog (No. 44) is now ready for distribution and copies may be had by writing Robert H. Clark Company, 9330 Santa Monica Boulevard, Beverly Hills, California.

▲ Bulletin No. 5-A illustrates and describes a handy tool for safely removing and replacing fuses, adjusting switch and fuse clips, handling test tubes, etc. Dangers of shocks, burns, lost time and compensation penalties are eliminated. Made of genuine horn fibre, laminated for extra strength and long wear, the unit has rolled sealed edges to avoid moisture absorption. It is available in four sizes and is also available in two sizes in bakelite for use where extreme moisture conditions exist, or where an extremely fine tool is desired.

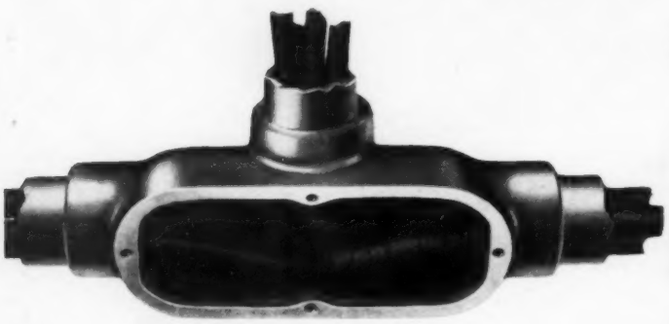
Write for your free copy to the Trico Fuse Mfg. Company, 2948 North 5th Street, Milwaukee 12, Wisconsin.

Wherever you need **more room** for unusual splicing, tapping, or pulling requirements,

use Form 8

CONDULETS

(CONDULETS are made only by CROUSE-HINDS)



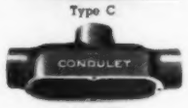
Type E

Type LR

Type LL

Type LB

Type C



Type TB

Type T

Type X

Large wiring chamber is both wider and longer. Will accommodate more or larger conductors.

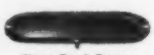
Extra wide surface for gasket between Condulet and cover.

Dome shaped blank covers in sheet steel or cast Feraloy provide extra wiring space.

Bakelite covers, either blank or with two wire holes and three knockouts. Blank Bakelite covers may be drilled when more than five wires are required or to meet special requirements.

Sizes. Thick wall threaded 1¼" through 4". Thin wall threadless 1¼" through 2".

A Nationwide Distribution Through Electrical Wholesalers


Sheet Steel Cover

Blank Bakelite Cover

Cast Feraloy Cover

Bakelite Cover with Wire Holes

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• ***A NATION'S THANKS*** to the men of the automotive industry for meeting and continuing to beat the wartime task of transporting men and materials in record-shattering volume.

And an orchid or two to the engineers who designed Hyatt Roller Bearings into their equipment to assure the best performance under the most gruelling conditions.

HYATT *

* *There is a size and type of Hyatt Roller Bearing for every application. Further information on any type for your specific purpose gladly furnished.*

HYATT BEARINGS DIVISION · GENERAL MOTORS CORPORATION

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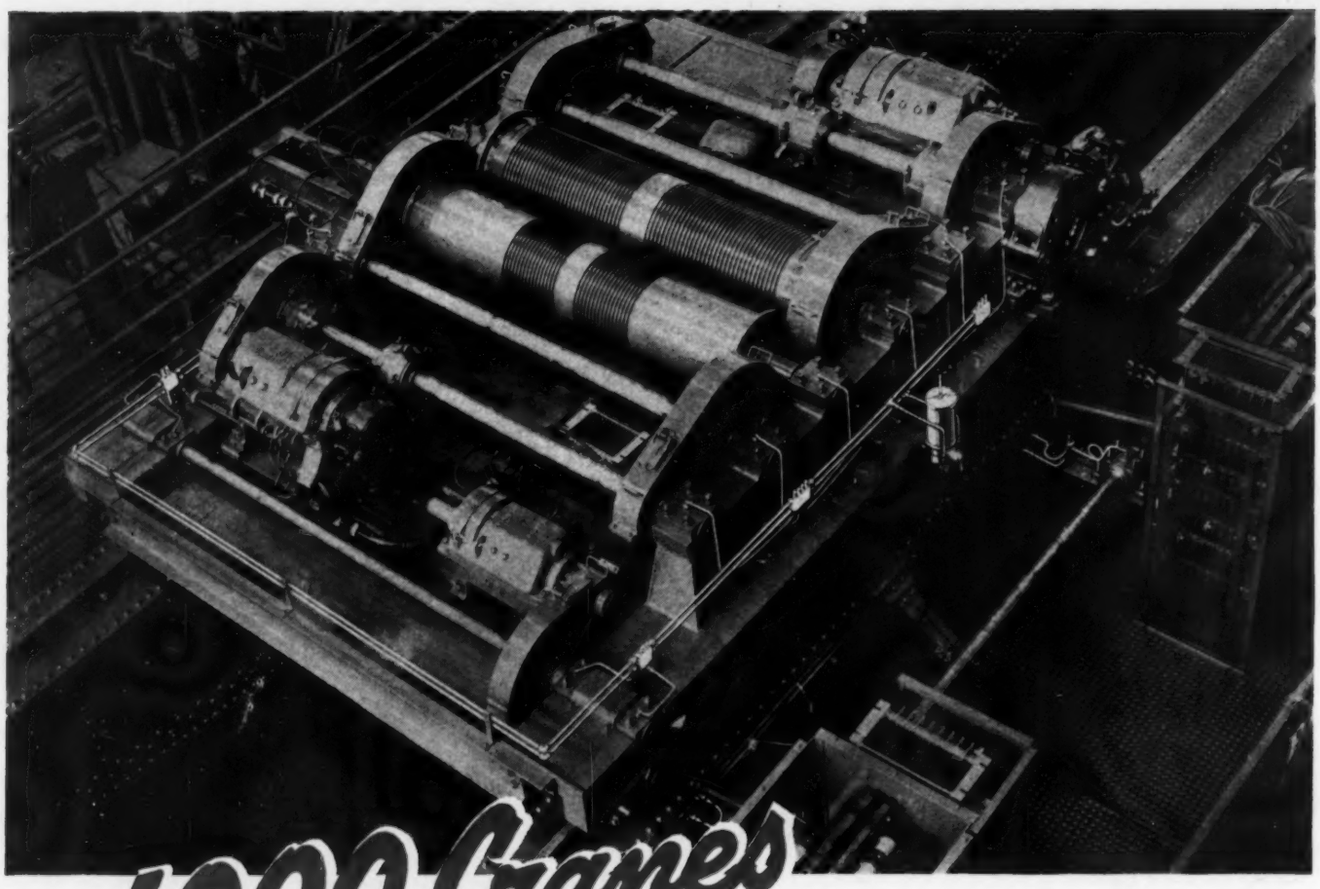


1,000 Cranes in less than 5 minutes!

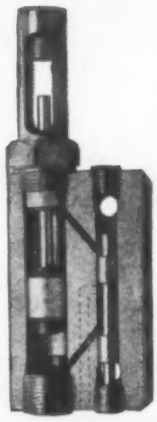
Each one of a thousand Farval-equipped Cranes receives complete and positive lubrication in less than 5 minutes and —not a bearing is missed.

An overhead crane shutdown can be as serious as the stoppage of any floor-level machinery. Centralized lubrication therefore is more essential on the isolated overhead equipment, which cannot be inspected from the floor and where you may risk serious injury to lubricate the hard-to-get-at bearing.

With Farval every bearing gets proper attention from a safe central point protecting all bearings between mechanical inspections. Farval also:—

Reduces labor of oiling 90% . . . Delivers clean grease and prevents over-lubrication . . . Eliminates drippage . . . Gives more time for a better job of inspection.

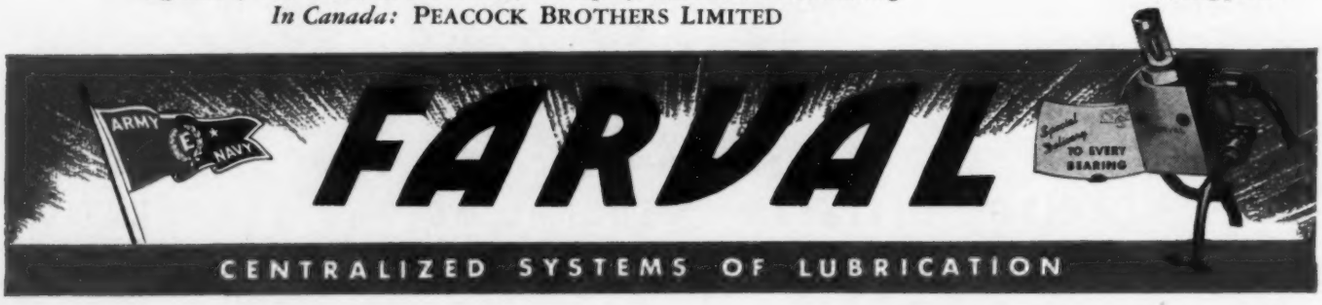
Protect your overhead Cranes—keep them rolling on 24-hour schedules. *Install Farval!*



Farval—The Dualine Valve without springs, check valves or small ports—is indicating, adjustable, and has but 2 moving parts.

The Farval Corporation, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing.
In Canada: PEACOCK BROTHERS LIMITED



Personnel News

Charles H. Slaughter has been named sales manager for Thomas Machine Manufacturing Company, Pittsburgh, Pennsylvania, to head an expanded sales program soon to be announced by the company.

Widely known in the machinery and metal industries, Mr. Slaughter began his industrial career as engineer and designer for American Steel and Wire Company, Carnegie-Illinois Steel Corporation, and Jones and Laughlin Steel Corporation. He then established his own machine tool agency in Texas. Later he became general sales manager of the former Wilmarth and Morman Company, Grand Rapids, Michigan, and general manager of Kent Machine Company, Cuyohoga Falls, Ohio. Before coming with Thomas he served as general sales and dealer relations manager for Liberty Planers, Inc., Hamilton, Ohio

Mr. Slaughter received his education in mechanical engineering at Carnegie Institute of Technology and Virginia Polytechnical Institute, also taking a law degree at Cumberland University.

John W. Sands, who has been with the conservation division of the War Production Board at Washington, District of Columbia, since January, 1942, has resumed his duties with the development and research division of The International Nickel Company, Inc., at New York.

J. B. Kintner, who has been associated with the Union Steel Castings Division of the Blaw-Knox Company for the past eight years, has been promoted to vice president of the division. Mr. Kintner joined the Union Steel Castings Division in 1936 after an 11-year association with the American Rolling Mill Company.

S. L. Eastman has been appointed chief engineer of The Cleveland Worm and Gear Company, Cleveland, Ohio. Mr. Eastman has been connected with the company in various capacities since graduating from Case School of Applied Science in 1927. He was assigned first to the testing laboratory, later serving as sales engineer and assistant sales manager. Since April, 1942, he has held the position of assistant chief engineer. **G. H. Acker** continues as vice president in charge of engineering and production of both The Cleveland Worm and Gear Company and its affiliate, The Farval Corporation.

R. H. Musser has been appointed assistant general manager of sales of the Heppenstall Company, pending the recovery of **W. P. Ritenbaugh,** who has been ill for some time. Mr. Musser has had wide experience in both metallurgy and sales and has had long familiarity with the Heppenstall district office setup as a result of his work in the Chicago office.

Charles H. Kinzel, Jr., has been appointed sales promotion manager of the John C. Dolph Company, Newark, New Jersey. He was formerly associated with the advertising department of the Eclipse-Pioneer Division, Bendix-Aviation Corporation, Teterboro, New Jersey.

Robert Boyd Parker has been made assistant to the president, American Brake Shoe Company. His duties include sales research and coordination, and responsibility for liaison between the company's metallurgical and research laboratories and the sales and production staffs of its 59 plants. Born in San Francisco in 1911, Mr. Parker is a graduate of Hotchkiss School and Yale University.

Roy T. Giles has been appointed sales manager of the Atlas Lumnite Cement Company, United States Steel Corporation subsidiary. Mr. Giles joined the company in 1928. He has spent much of his time in the development of refractory concrete which is used for lining furnaces and other construction exposed to high temperatures. This use now constitutes a large volume of the present consumption of Lumnite.

Sperry L. Searles, who has been connected with the automotive field in and around Cleveland for the past 25 years has recently been elected president of H. B.

S. L. EASTMAN

R. B. PARKER

C. H. SLAUGHTER

Dependable
flexible couplings for the
IRON and STEEL INDUSTRY

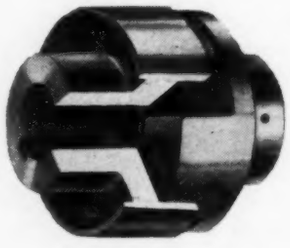
L-R FLEXIBLE COUPLINGS
NON-LUBRICATED

Dependably correct for misalignment, whip and backlash.

Dependably take up surge, shock and vibration.

Dependably operate with least service attention.

Cutaway view of L-R Type "H," for heavy duty inside, or exposed to weather. 4.60 to 806 h.p. at 100 r.p.m. Bores 1½" to 9½". Electric steel castings and greater number of jaws for maximum load carrying capacity.



The L-R principle of carrying load on free-floating cushions hung between rugged jaws, or held by specially designed steel collars or bands has long proved its exceptional dependability. Resilient cushions (of material best suited to service) are free to deform to every emergency. Internal friction is eliminated. Cushions are always in sight for inspection. CHANGES ARE EASILY MADE WITHOUT SHUT-DOWNS.

Send for Complete L-R Catalog, with Quick-Finding Selector Charts.

There's an L-R Flexible Coupling for every duty from 1/6 to 2500 h.p. Charts enable you to put your finger on the couplings desired in moments. Full engineering data right at hand. L-R Charts should be in every engineer's file.

Wire or write

LOVEJOY FLEXIBLE COUPLING CO.

5016 W. LAKE ST. CHICAGO 44, ILLINOIS

PITTSBURGH OFFICE: EDW. J. BOYLE CO., 508 GRANT ST.

Fuller Equipment Company of Cleveland, Ohio. Since 1936 The Fuller Company has been distributor in the northern Ohio territory for industrial electric lift trucks, industrial cars and quarry cars, truck bodies and semi-trailers built by The Easton Car and Construction Company of Easton, Pennsylvania.

Walter H. Wiewel has been made assistant to the president of National Tube Company, to engage in the planning and development of future markets and facilities for the production of tubular products.

Since 1942, Mr. Wiewel has served as chief, Tubing Branch, Steel Division, War Production Board, and also as vice chairman of W. P. B's. Production Directive Committee. He will begin his new duties with National Tube Company immediately.

Mr. Wiewel, a native of Cleveland, has held various sales and administrative positions with Cambria Steel Company, United Alloy Steel Corporation, Standard Seamless Tube Company, Timken Steel and Tube Company, and was employed as assistant general manager of sales of Jones and Laughlin Steel Corporation at the time he went to Washington to serve with the War Production Board.

Peter Robertson, assistant chief industrial engineer for Republic Steel Corporation has been appointed works manager of the Youngstown plant of Truscon Steel Company, Republic subsidiary.

A native of Glasgow, Scotland, Mr. Robertson at 16 came to this country and became an apprentice toolmaker at the General Electric Company. Joining Republic in 1934, he assisted in the introduction of modern production methods in the Berger Manufacturing Division and spent two years at Truscon in Youngstown in similar work. As assistant chief industrial engineer for the past two years, he has played a prominent part in the conversion of Republic manufacturing divisions to the manufacture of aircraft parts and sub-assemblies.

C. E. Homer, formerly assistant electrical superintendent of the Indiana Harbor Works, Youngstown Sheet and Tube Company, East Chicago, Indiana, has been appointed electrical superintendent, succeeding the late **George Adams.**

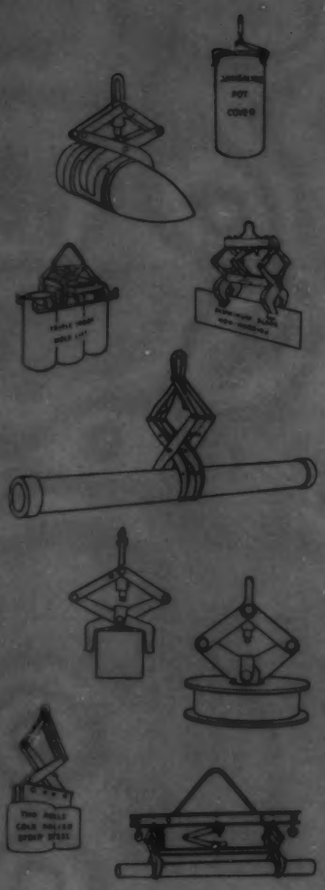
Paul B. Tonnar has become associated with the Carnegie-Illinois Steel Corporation on the chief engineer's staff. He was formerly chief engineer for the Andrews Steel Company, Newport, Kentucky.

J. R. Cramer and **F. J. Titler** have been appointed assistant chief industrial engineers of Republic Steel Corporation. Mr. Cramer has been division industrial engineer in the Youngstown plant of Truscon Steel Company, Republic's subsidiary. Mr. Titler has been located in Cleveland as a staff industrial engineer on steel plants, having formerly been located in Youngstown as district industrial engineer.

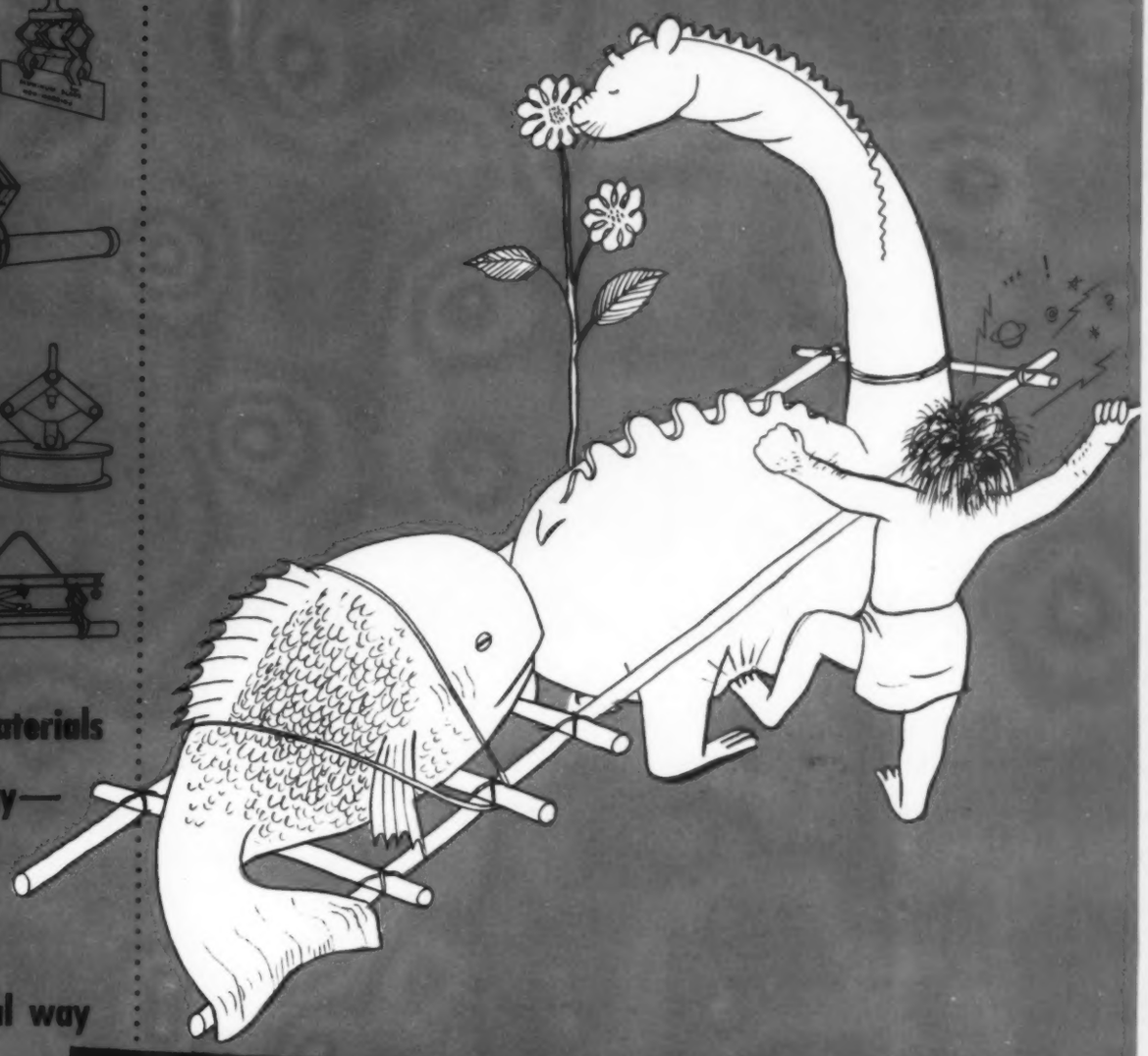
Daniel E. Wise has been appointed assistant chief engineer of the Clairton works of Carnegie-Illinois Steel Corporation. Mr. Wise was previously project engineer of the corporation's Youngstown district. He has been associated with Carnegie-Illinois in various engineering capacities for a number of years.

Charles W. Hill, formerly assistant general superintendent of The Wheeling works of Continental Foundry and Machine Company, has been appointed general superintendent of that plant.

A. F. Sprankle has been appointed Metallurgical



WHY BE PRIMITIVE ?



Handle your materials the modern way— the faster, safer, more economical way

use

Heppenstall Safe-T-Tongs

. . . But materials' handling doesn't *have* to be inefficient. Chains, hooks and other antiquated holds are unnecessarily slow—costly—dangerous. Heppenstall Safe-T-Tongs pick-up, land and release a load by simply raising and lowering the crane. No power or close work by ground crews needed. Heppenstall Tongs are automatic—positive—proved. And Heppenstall makes 'em to handle any weight, shape or type of material . . . If you have a repetitive handling job in your plant you can certainly cut its cost with a Heppenstall Tong. Write for Safe-T-Tong booklet. Heppenstall Company, Department TP, Pittsburgh, Pa.

FORGING FINE STEELS FOR OVER 55 YEARS

PROTECT YOUR OPERATING INVESTMENT

Install ROCKBESTOS A.V.C.

In Lighting, Power and Control Circuits Exposed to High Operating Temperatures

You can practically eliminate shut-downs and production delays caused by repeated wire-failures by installing Rockbestos A.V.C.—*the wire with permanent asbestos insulation*—in all electrical circuits that run around furnaces, lehrs, kilns, soaking pits, or in steam tunnels and other locations exposed to heat or severe operating conditions.

Rockbestos A.V.C. wires, cables and cords have a *permanent* impregnated asbestos insulation that stands up under operating temperatures ranging as high as 230°F. It is naturally heatproof, flameproof, and won't bake brittle, dry out, crack, bloom, rot or swell. It also resists heat, cold, moisture, oil, grease, alkalies, corrosive fumes and other destructive elements and gives trouble-free service where other constructions fail.

Protect your operating investment . . . install Rockbestos A.V.C. in lighting, power and control circuits operating in hot-spot locations. 122 constructions give you a wide range of selections to meet your specific requirements. When ordering or inquiring, please furnish priorities information required under CMP regulations. For complete information and samples, write nearest branch or:

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NEW YORK, BUFFALO, CLEVELAND, CHICAGO, PITTSBURGH, ST. LOUIS, LOS ANGELES, SAN FRANCISCO, SEATTLE, PORTLAND, ORE.

THE ROCKBESTOS CONSTRUCTION that provides long wire life

Rockbestos A. V. C. Power Cable, at left, and similarly insulated Motor Lead Cable (National Electrical Code, Type AVA) has a maximum operating temperature rating of 110° C. (230° F.) and this permanently insulated construction:

1 A tough, rugged asbestos braid, resistant to heat, flame, moisture, oil, grease and corrosive fumes.

2 Outer felted asbestos wall, impregnated with heat, flame and moisture resistant compounds, serves as an effective barrier against high ambient temperatures and flame.

3 Lubricated varnished cambric for high dielectric strength and added moisture resistance, protected from heat, flame and oxidation between two felted asbestos walls.

4 Felted asbestos insulation, also impregnated with heat, flame and moisture resisting compounds, withstands conductor heating overloads and won't dry out, bake brittle or burn.

5 The conductor is perfectly and permanently centered in helically applied insulation.

One of 122 different wires and cables developed for severe operating conditions by Rockbestos.

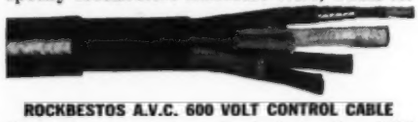
WON'T bake brittle, bloom, burn or rot.
RESISTS moisture, oil, grease and fumes.

ROCKBESTOS 600 VOLT ALL-ASBESTOS RHEOSTAT AND POWER CABLE

(National Electrical Code, Type AI)

Sizes No. 18 AWG to 1,000,000 CM insulated with a heavy wall of felted asbestos, covered with a rugged asbestos braid finished in black, white or colors.

Use this power and rheostat cable for wiring rheostats, switchboards, elevator and locomotive control panels and electrical equipment exposed to heat, fumes and fire hazard. Also for general open wiring in dry, high temperature locations. For solid conductor specify Rockbestos Rheostat Wire, Table A.



ROCKBESTOS A.V.C. 600 VOLT CONTROL CABLE

In one to 19 conductors. Standard stranding AWG No. 12—19 /No. 25 and No. 9—19 /No. 22. Other strandings furnished.

Designed for use under conditions too severe for control cables with other types of insulation which deteriorate rapidly when exposed to high temperatures. This Rockbestos A.V.C. Cable operates without failure under the attack of heat, oil, grease or corrosive fumes and may be installed in conduit as it has ample moisture resistance.

ROCKBESTOS A.V.C.

The Wire with Permanent Insulation

• BUY MORE WAR BONDS •

Engineer in The Timken Steel and Tube Division, according to a recent announcement by The Timken Roller Bearing Company, Canton, Ohio. He was formerly manager of the alloy bureau of Carnegie-Illinois Steel Corporation in the Pittsburgh district.

A graduate of Ohio State University, with a B.S. degree in metallurgical engineering, Mr. Sprankle has done three years of laboratory work at Batelle Memorial Institute in Columbus, Ohio. In 1934 he first joined Timken, specializing in bearing and high temperature steels.

R. W. Owens has been elected vice president in charge of manufacturing at Elliott Company, Jeannette, Pennsylvania. Mr. Owens joined Elliott Company as assistant to the president in February, 1944, having previously had a wide experience of some twenty-eight years in the design and manufacture of electrical products.

Frank H. Stohr has been named assistant to the president of Elliott Company, Jeannette, Pennsylvania. With Westinghouse Electric and Manufacturing Company since his graduation in electrical engineering from the University of Iowa in 1922, Mr. Stohr was made manager of the generator sales section of that company in 1926. Successively, he became sales manager of the generating division, manager of the generating and transportation manufacturing division, and manager of the industry sales department in 1939, which position he held until joining Elliott Company.

Godfrey H. Atkin, special representative, Chicago branch, The Electric Storage Battery Company, was recently presented with a certificate by the National Electrical Manufacturers Association in recognition of his half-century service to the industry. Mr. Atkin has been with Exide since 1902. His association with the electrical industry started in 1890 with the Thompson Houston Company. In 1892 he entered the employ of the General Electric Company where he remained until 1899 when he left to become associated with the Electrical Vehicle Company, Hartford, Connecticut, and later with the Woods Motor Vehicle Company, Chicago.

Obituaries

J. E. Wilson, sales engineer for the United Steel Corporation, Toronto, Ontario, Canada, was killed recently in an automobile accident. Mr. Wilson was a graduate of the Hamilton Technical School and the Buffalo Technical School. Before joining United Steel six years ago, he had served as chief engineer and assistant manager of the Standard Steel Construction Company, a subsidiary company. Mr. Wilson was chairman of the reception committee of the Buffalo District Section of the Association of Iron and Steel Engineers and was active in the affairs of this new section.

John Thomas Tierney, president of Koppers United Company and chairman of the board of Koppers Company, died recently in New York. Mr. Tierney was born on a farm near Woodland, Wisconsin, and was graduated from the University of Wisconsin in 1908 with a degree in mechanical engineering.

He joined the Laclede Gas Light Company, St. Louis, Missouri and in 1912 was made assistant engineer and superintendent of the plant, remaining with the company in that capacity until 1916 when he joined Koppers.

NATIONAL ROLLS

FOREIGN TRADE IN STEEL

PREVIOUS wars have been waged in limited terrain, and their devastation confined to small areas.

But the destruction of this war, by reason of bombing raids, covers entire national areas.

Thus no surveys yet made can estimate the gigantic size of the corrective job ahead—but it is clear that in practically all reconstruction, the need for steel will be paramount.

The American steel industry, with increased capacity, will supply much of that steel in what may form the greatest export volume our nation has ever known.

And NATIONAL ROLLS, abreast of all that is sound and modern in the rolls industry at large, will do their share in shaping the steel needed.

The NATIONAL ROLL & FOUNDRY COMPANY

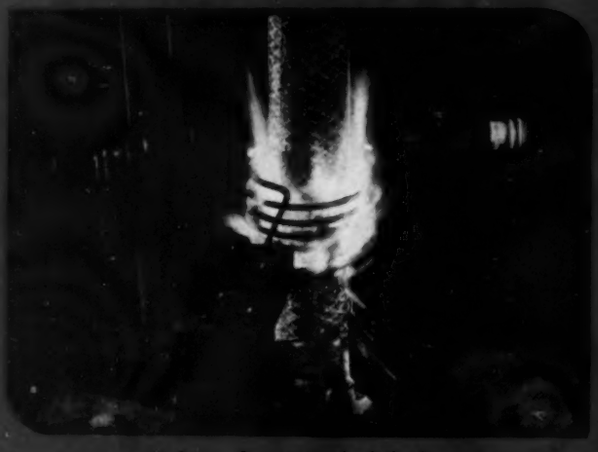
All Grades of Cast Rolls—Iron and Iron Alloy—Steel and Steel Alloy
Heavy Iron Castings and Rolling Mill Equipment

AVONMORE, PA.

● Applying an Okoseal impervious synthetic sheath over a large Navy shipboard cable.

OKOSEAL

...an Okonite "First" for the Navy that will benefit You



● Severe flame tests check the fire resistance of Okoseal shipboard cables.

● It is easy to make terminals or splices on Okoseal insulated wires.

The Navy, in their efforts to reduce fire hazards in warships, needed a non-flammable dielectric material for cable use that would still have moisture resistance and flexibility like the rubber compounds then standard. A synthetic thermoplastic under investigation ten years ago in Okonite's Research Laboratory had such characteristics and lengths of wire insulated with this material were submitted to the Navy for test – with satisfactory results. In addition it was found that this new material, called Okoseal, was also resistant to heat, oils and chemicals.

Okoseal was then adopted by the Navy for conductor insulation and impervious sheaths on Navy shipboard cable. Other manufacturers were soon placed in a position to make this type of cable and the Navy incorporated the new design in their specification.

Thus, long before Pearl Harbor, Okonite research was the first to place in the hands of the Navy a wire insulation that did not depend upon foreign-controlled rubber and yet provided improved characteristics.

Okonite next adapted versatile Okoseal to commercial use as the first light-wall, small diameter building wire – a modern development that permits a substantial increase in the capacity of electrical conduits and makes possible low cost *re*wiring of electrically obsolete buildings.

Tough and weather-resistant, Okoseal is also employed today for insulating and protecting many other kinds of wires and cables. Ask an Okonite sales engineer to show you where you can use them to very great advantage. The Okonite Company, Passaic, New Jersey.

OKONITE "FIRSTS" FOR THE NAVY

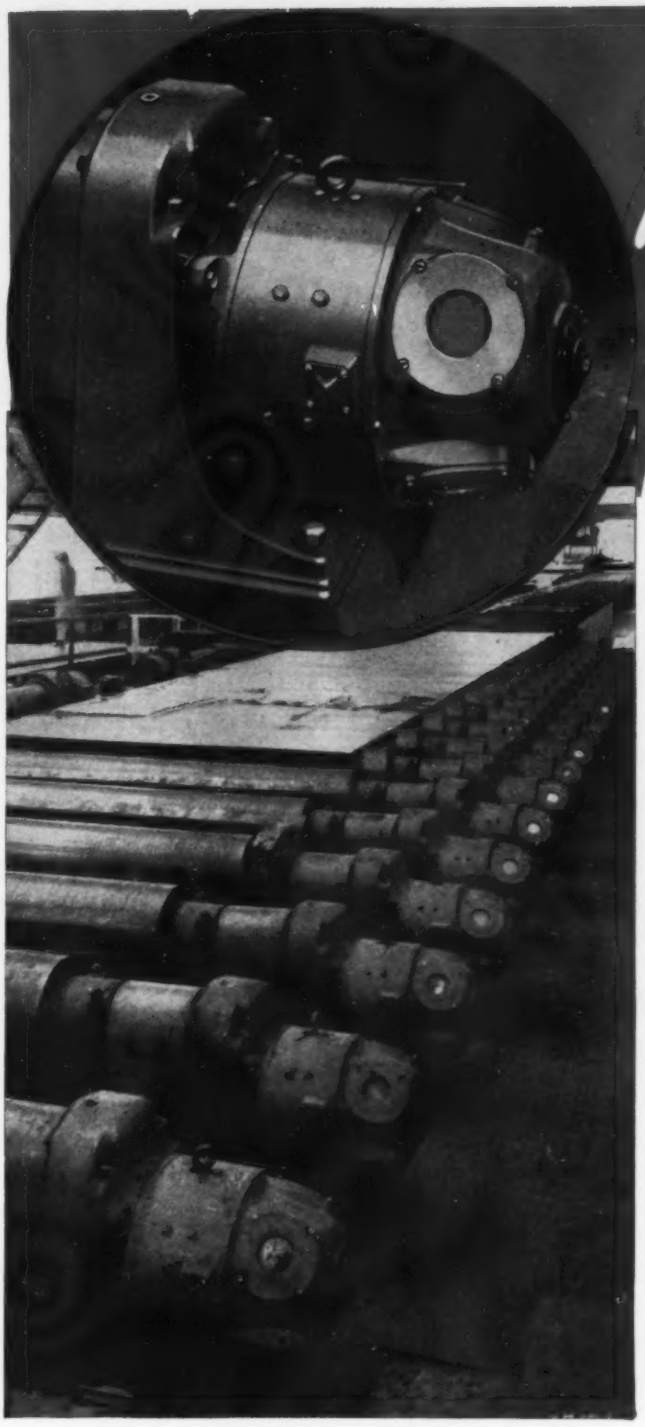
- First to offer a corrosion-resistant lead alloy coating for copper conductors ("Okoloy")
- First to develop a method of assembling conductors to increase resistance against twisting ("Unilay")
- First to supply conductors insulated with a non-flammable synthetic dielectric ("Okoseal")
- First to protect conductors with flame-resistant glass fiber insulation ("Okoglass")
- First to manufacture the synthetic impervious sheath for protecting cables ("Okoseal")

ARMY-NAVY

OKONITE

insulated wires and cables

3817



No Traffic Jams on THIS INSPECTION TABLE!

The fact that doing it electrically with Reliance Motor-drive helps to keep plate traffic moving steadily over this inspection table is only part of the story. Proving again that *motor-drive means more than power,* the Reliance table drive also contributes these steady-production features:

Clear access between rolls for under-side inspection.

Ability to start, stop and reverse rolls smoothly, with quick acceleration and deceleration.

Table speeds variable to suit plates of different sizes and thickness.

And, because of its individual drive, a single roller can be readily removed for repairs — a damaged roller doesn't hold up production.

Any Reliance man will be glad to furnish you details regarding this and other applications of Reliance Motor-drive which can help to promote better production and lower costs in modern plate mill operation. Call our nearest office, or write directly to us at Cleveland.

140" Plate-mill inspection Table. Rollers individually driven by D-c Reliance Gearmotors 4.3 to 1 ratio. Enclosed motor units with Class B insulation. Speed control by voltage control.

RELIANCE ELECTRIC & ENGINEERING CO.

1088 IVANHOE ROAD • CLEVELAND 10, OHIO

RELIANCE A-C D-C MOTORS

140" Plate-mill Inspection Table • Rollers individually driven by D-c Reliance Gearmotors 4.3 to 1 ratio • Enclosed motor units with Class B insulation. Speed control by voltage control.

PLAN YOUR PLANT DRIVE NOW!

Good organization will be needed to sell the 6th. The task of raising the huge sum required will be the most difficult ever asked of Industry. As each new military success brings us closer to Victory, the public naturally will feel that the urgency of war financing is lessened—whereas it isn't. So organize now to prevent a letdown on the home-front from causing a letdown on the fighting front. Build your plant's payroll campaign around this fighting 8-Point Plan. You don't have to wait for the official Drive to start—swing into action NOW!

1 **BOND COMMITTEE**—Appoint a 6th War Loan Bond Committee from labor, management and each representative group of the firm.

2 **TEAM CAPTAINS**—Select a team captain, for each 10 workers, from men and women on the payroll—but not in a supervisory capacity. Returned veterans make most effective captains.

3 **QUOTA**—Set a quota for each department and each employee.

4 **MEETING OF CAPTAINS**—Give a powerful presentation of the importance of the work assigned to them. Instruct them in sales procedure. Have them carefully study the Treasury Booklet, *Getting the Order.*

5 **ASSIGNMENTS**—Assign responsibilities for:

(a) *Music, speeches and announcements of the opening rally.*
(b) *Pre-drive letter to employees from management and labor.*
(c) *Competitive progress boards.*
(d) *Meeting schedules, etc.*

6 **CARD FOR EACH WORKER**—Dignify each personal approach with a pledge, order, or authorization card made out in the name of each worker. Provide for a cash purchase or installment pledge. Instruct each captain to put a pencil notation on the card to indicate the subscription he expects to solicit from each worker.

7 **RESOLICITATION**—People don't mind being asked to buy more than once. Resolicit each employee toward the end of the drive in a fast mop-up campaign. Call upon your State Payroll Chairman; he's ready with a fully detailed plan—NOW!

8 **ADVERTISE THE DRIVE**—Use all possible space in the regular media you employ to tell the War Bond story.

The Treasury Department acknowledges with appreciation the publication of this message by

Iron and Steel Engineer

This is an official U. S. Treasury advertisement prepared under the auspices of Treasury Department and War Advertising Council

for CONTINUOUS
TROUBLE FREE Resistor SERVICE

★ ALL STEEL CONSTRUCTION
★ MICA INSULATION
★ RUGGED TERMINALS
★ PROVISION FOR EXPANSION
★ ADEQUATE VENTILATION
★ UNAFFECTED BY VIBRATION
★ MOISTURE RESISTANT
★ CORROSION PROTECTED

Steel and Mica, the two basic materials entering the construction of P-G Steel Grid Resistors, are the foundation for continuous trouble free resistor service. P-G uses these materials in a unique design to provide both for expansion and for maximum ventilation. For more detailed information, ask for a copy of Bulletin No. 500 * * * *

P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY
• ESTABLISHED 1892 •
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FOR a good many years we have talked about how Jones speed reducers, gears and other transmission products have been built for long trouble-free service. Some people might have said that we placed too much emphasis on ruggedness, stamina and the ability of our products to "stand up and take it".

But today in every phase of war work, industry is calling for products that will measure up to these standards by continuously staying on the job.

Our Bulletin No. 80 "Jones Drives for Industry" will give you a complete outline of the range of Jones speed reducers, gears and other transmission products that are built to stand the 24-hour a day drive for victory. We shall be glad to mail you a copy.

W. A. JONES FOUNDRY & MACHINE CO., 4431 Roosevelt Road, Chicago, Illinois

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CUT AND MOLDED TOOTH GEARS • V-BELT SHEAVES • ANTI-FRICTION
PILLOW BLOCKS • FRICTION CLUTCHES • TRANSMISSION APPLIANCES

What 20 men learned in 20 years

-this book tells you in 20 pages

Probably a score of our engineers, research and field men have each devoted an average of twenty years to the study of grease-type lubricants. To put their experience into print was in itself a considerable job, but we've done it, and the result is available to you, free.

This book is brief but concise. It will give you a little better understanding of grease compounding, types of greases, the merits of each, and the Houghton products evolved over years of serving industry.

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E. F. HOUGHTON & CO.

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and Holly...

and

Christmas Seals

THEY only come once a year—turkey and holly, carols and cranberry sauce!

And only once a year do you get a letter enclosing the seals that save life — *Christmas Seals.*

Answer the letter! Christmas Seals make possible the year-round fight against Tuberculosis and are *your gift to all humanity.*

What better way to remember His birthday?

BUY CHRISTMAS SEALS!

The National, State and Local Tuberculosis Associations in the United States

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Oil Immersed MOTOR CONTROL

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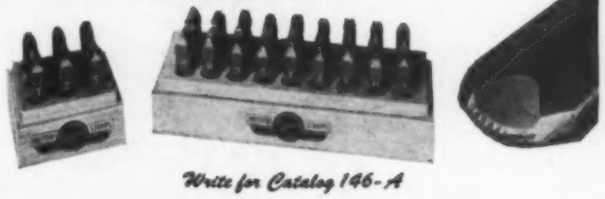
BY USERS EVERYWHERE

ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.

Matthews "Safe-Hed"

Matthews "Safe-Hed" Steel letter and figure stamps . . . used for 90% of industrial stamping needs . . . are available from stock in a complete range of sizes. Stamps with two or more characters, symbols or designs made to order for marking flat, concave or convex surfaces.



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Automatic Control GIVES YOU...

MORE INGOTS

BETTER INGOTS

at Lower Cost

ARMY E NAVY

FROM YOUR PRESENT SOAKING PITS

Here's the reason why 81% of all the new soaking pits installed in the last 5 years were Askania Automatic Controlled . . . modern steel making demands increased volume . . . higher quality and closer control of scale formation. Records prove Askania's ability to give you . . . more ingots . . . better ingots . . . at lower cost . . . yes, from your present soaking pits!

FREE Our Bulletin No. 116 gives you full details of Askania Soaking Pit Control. This data should be in every steel man's files . . . write for your copy today . . . no obligation.

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ASKANIA REGULATOR CO.

1603 S. MICHIGAN AVENUE, CHICAGO 16, ILL.

Quick-As-Wink CONTROL VALVES

This Quick-As-Wink valve can be supplied with ¼", ⅜", or ½" standard pipe thread.

All Quick-As-Wink valves are guaranteed unconditionally to perform satisfactorily.

PRESSURE SEALED
PERMANENTLY LEAK PROOF
SIMPLE, STURDY CONSTRUCTION

This new type of Quick-As-Wink cam valve can be mounted for either right or left-hand operation. It is ideal for use on any traveling or moving device which can accommodate a valve.

To assure resistance to wear and corrosion, we use stainless steel for the valve plunger — alloy steel, hardened and lapped, for the pins, collars, rollers, and cam lever, and bronze for the valve cage.

Place Your Order Today.

C.B. HUNT & SON

1863 E. PERSHING ST., *Salem, Ohio*

THE HIGHER THE PRESSURE
AIR
WATER
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THE TIGHTER THE SEAL

Palletized Unit Loads

. . . eliminate unprofitable handling
. . . cut handling time of operations
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Electric Industrial Trucks

. . . permit faster loading, unloading and load shifting

Exide BATTERIES

. . . assure uniform hauling speeds
. . . give long life (They're built to last)
. . . provide easiest maintenance ever devised

Write for a FREE copy of the booklet "Unit Loads," prepared by the Industrial Truck Statistical Association.

An efficient materials handling system that accelerates the flow of materials and provides important savings in cost and manpower.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 32
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OHIO
Extra Strength MAGNETS

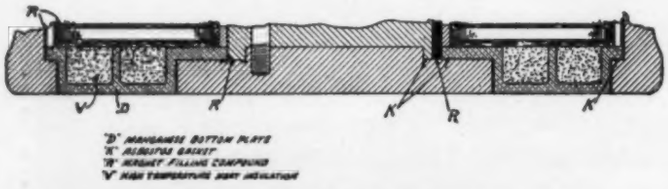
The OHIO 6 pancake coil magnets in the 55" and 65" diameters will average 35% better lifts than the standard magnets.

The OHIO 8 pancake coil magnets will average 75% more than the standard magnets.

Labor cost per ton and time required to handle are both reduced correspondingly.

Numerous repeat orders testify that performance equals or exceeds the statements above.

★When OHIO magnets are required to lift hot materials the heat resisting bottom construction shown below successfully retards the flow of heat from the load to the magnet coil and permits all day use.



Have you a problem requiring fast lifting or lifting of hot steel?

The OHIO Electric Mfg. Co.
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Keep Portable Tools In Constant Service

Foremost makers* recommend the use of NON-FLUID OIL after determining by prolonged service tests that it helped their tools perform most efficiently over long periods.

What's more NON-FLUID OIL not only reduces maintenance and repair cost, but saves money on lubricant and labor expense because it lasts longer.

NON-FLUID OIL is being used successfully in leading iron and steel mills. Send for instructive bulletin.

*Names on request.

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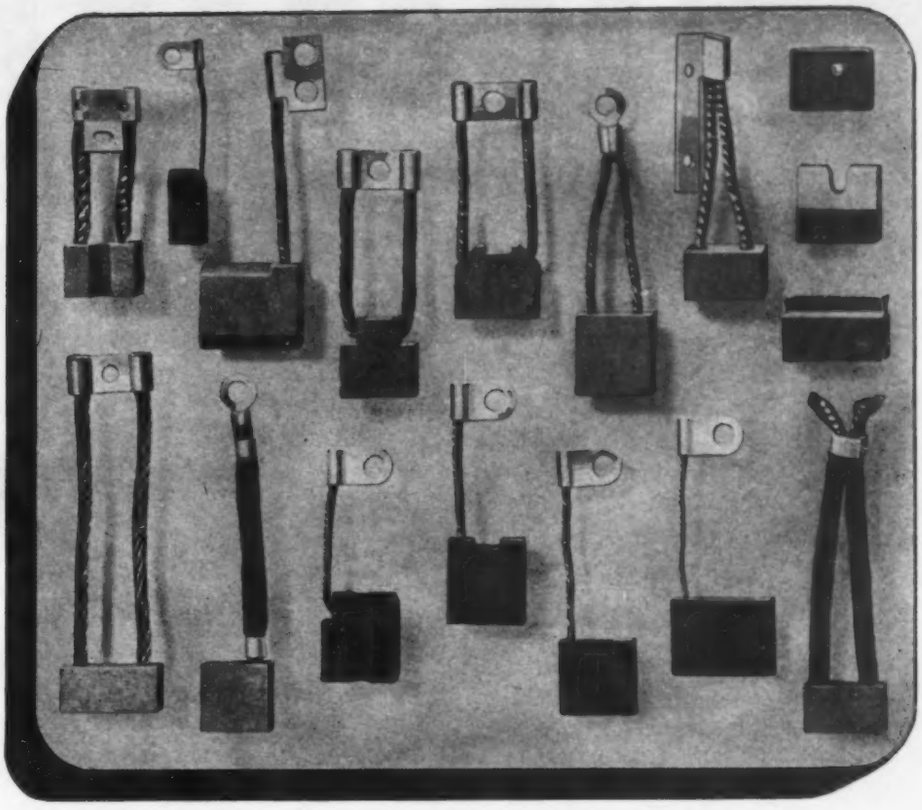
TRADE MARK REGISTERED
NON-FLUID OIL
IN U.S. PAT. OFFICE & FOREIGN COUNTRIES

Modern Steel Mill Lubricant

Better Lubrication at Less Cost per Month



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LIKE MOTORS and generators—brushes too must be designed with variations in construction in order to obtain maximum performance from commutating equipment. Matching brushes to machines is a specialty at Speer. For nearly 50 years we have been helping manufacturers and users of motors, generators and other commutating equipment find the right solution to current collecting problems. So when it comes to selecting the proper brushes for any requirements or solving commutation problems, you can come to Speer with assurance of getting sound practical advice plus quality brushes that will match your needs.

In addition to a wide variety of standard brushes, special brushes as illustrated are developed to meet the needs of various types of equipment.

To obtain prompt service, send for Brush Data Forms—one for each machine on which you have a problem. Just fill in the required information—return and we will gladly submit our recommendations.

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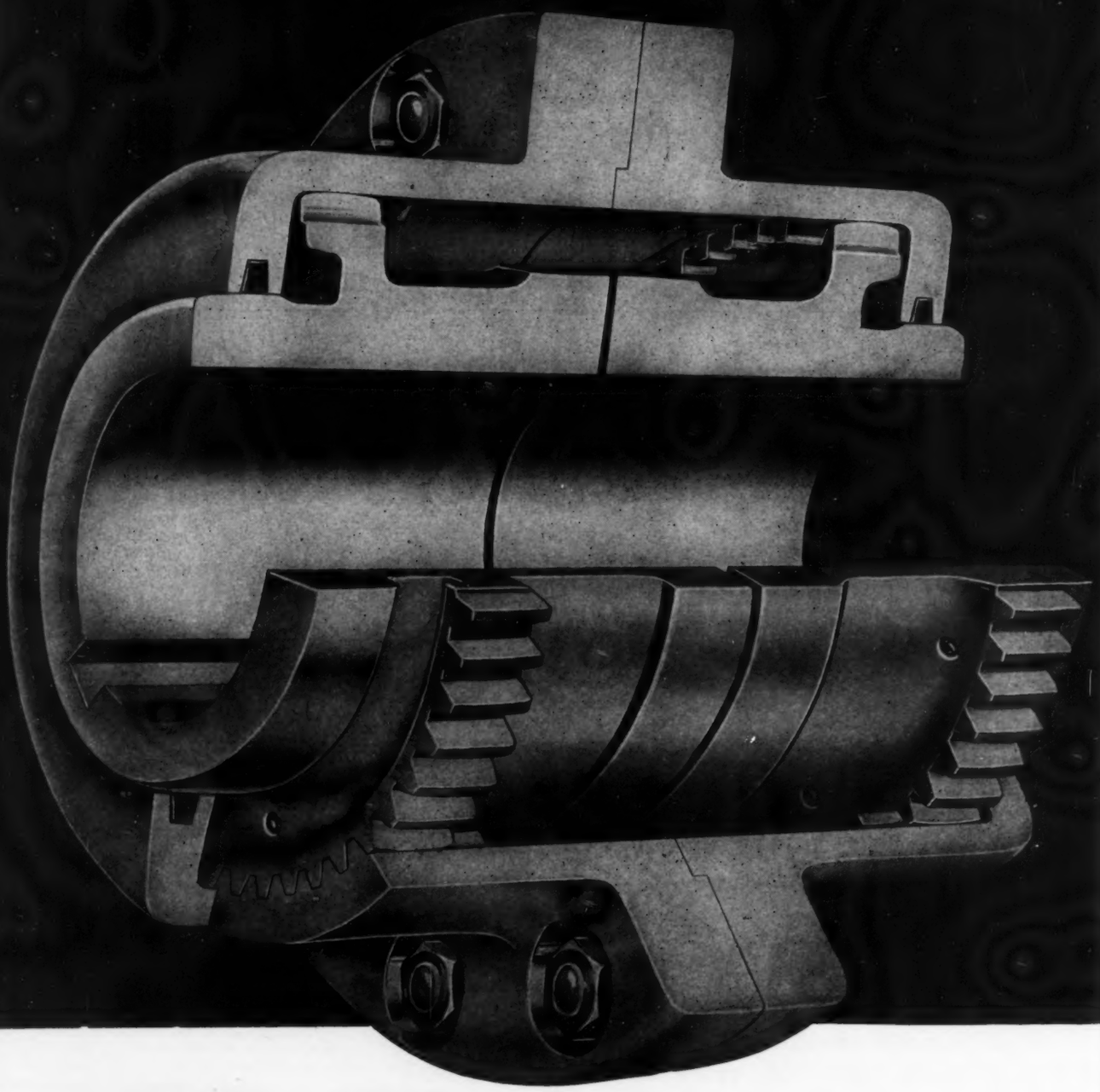

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POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

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PIPE CLEANING SERVICE

ITS PURPOSE . . . To provide a Complete Engineering and Operating Service for Industry.

SCOPE OF WORK . . . To Solve Production and Maintenance Problems where Pipe, Tubes or Conduit are used.

Cleaning Should Be Investigated *if . . .*

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- Sewers or Waste Water Lines Do Not Function Freely
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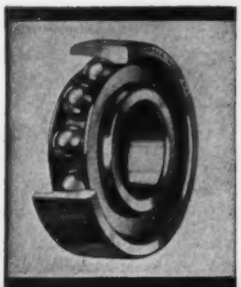
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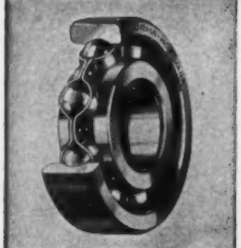
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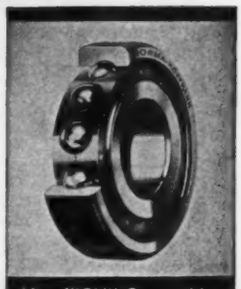
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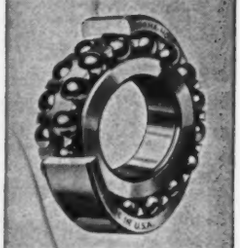
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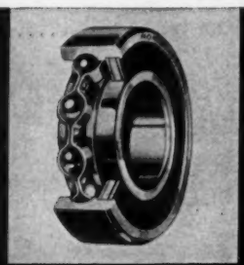
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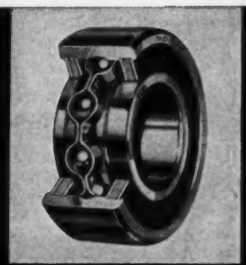
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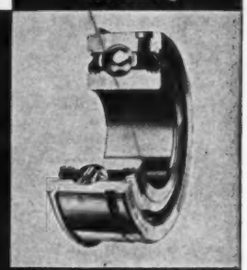
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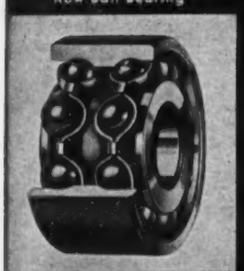
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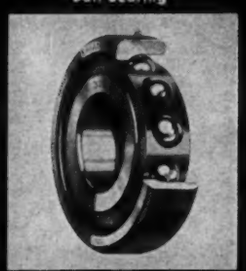
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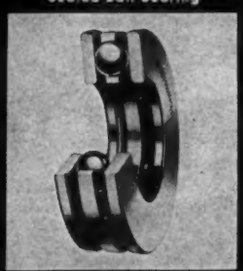
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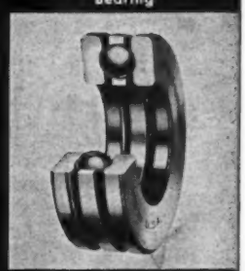
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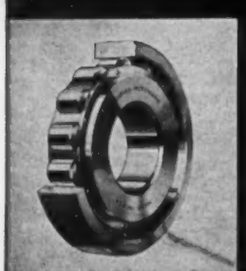
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6 **MAINTENANCE OF CIRCUIT BREAKERS** — **Bulletin 4408**
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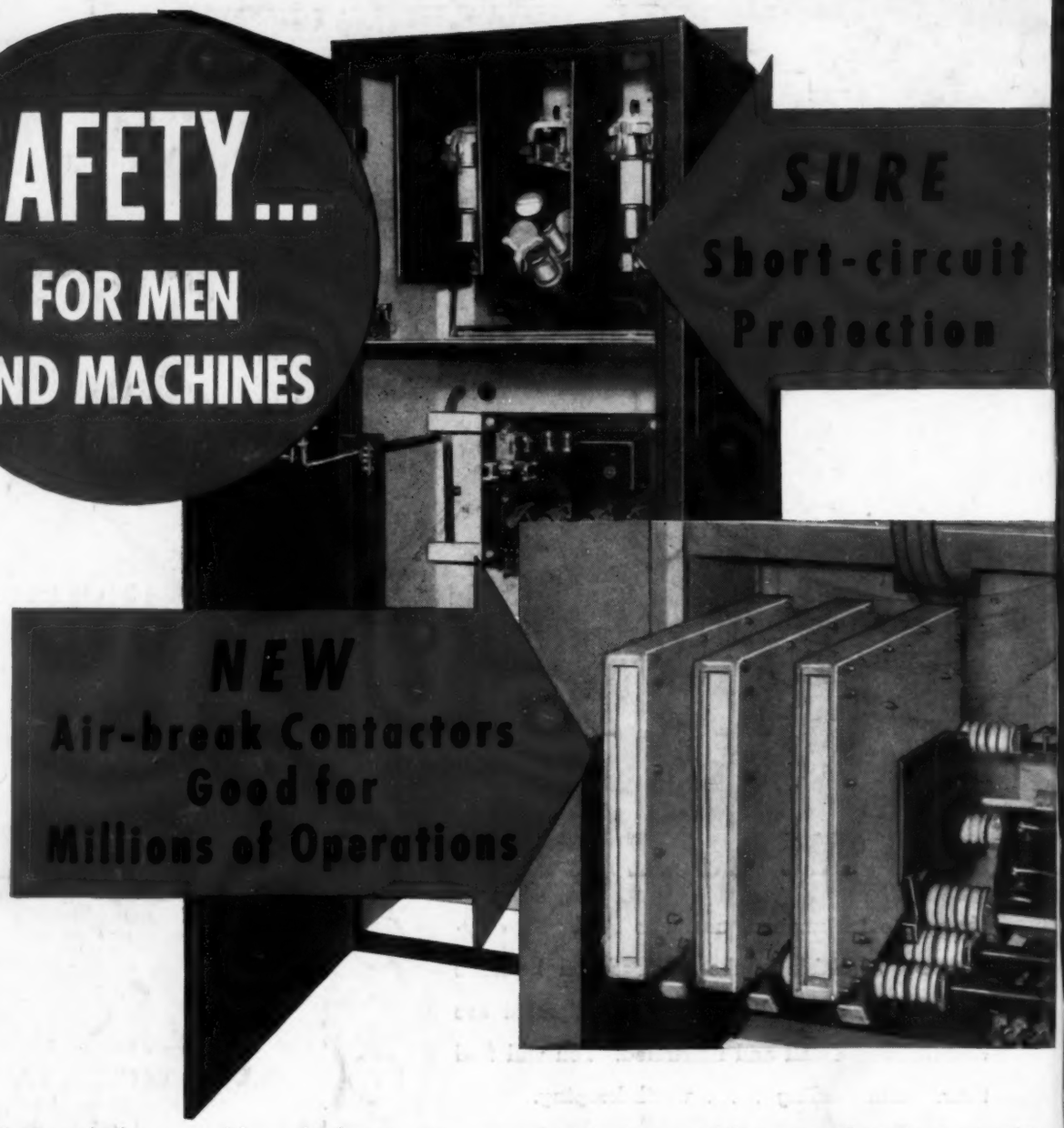

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